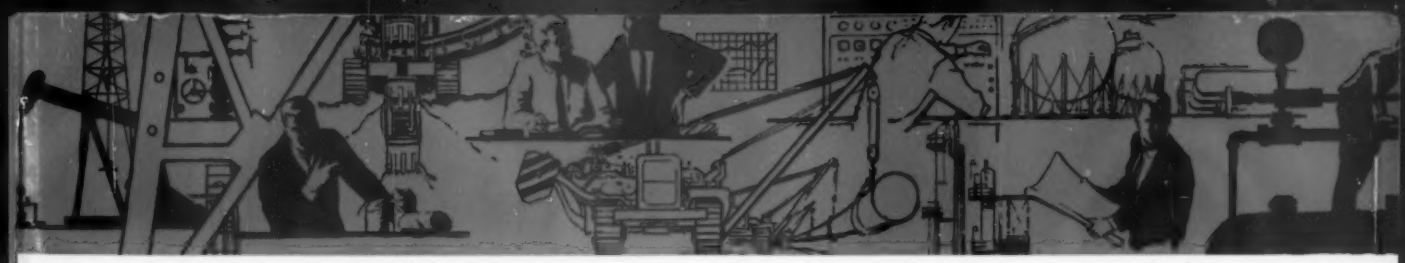

Petroleum Management

A PETROLEUM ENGINEER PUBLICATION September, 1961

First Half Profits Up 13%

Nationals Get Job Advantages

How to Conduct Conferences

Global Data on 135 Areas

People in Petroleum

Energy in the USA, 1975

Simple Deliverability Estimates

Engineering Largest African Field

Keep Your Fleet Rolling

Iraq Pipeline Ahead of Schedule

Oxidation Processes in HPI

how Dowell planning helps make your frac jobs more profitable

Planning often makes the difference between the financial success and failure of a frac job. Here are four of the important planning steps Dowell engineers often recommend. When these steps are performed, there is no extra charge.

TESTING of formation samples and produced fluids with treating chemicals at Dowell laboratories helps avoid emulsion or plugging problems that might limit production increases. These tests are not always needed, but they are recommended whenever well conditions are encountered that vary from past studies, for example, in wildcat wells and edge wells.

SELECTING the most promising frac fluid and propping agent is aided by Dowell's fracture conductivity testers. Different treatment combinations can be compared and the most desirable one selected.

CALCULATING probable results for various sizes and types of treatments can be done by an electronic computer programmed with Dowell's engineering method—the Frac Guide*. Production increases and payout times are predicted, enabling the operator to select the optimum treatment for his purposes.

TIMING of a frac job is vital if an operator wants the maximum ultimate recovery with minimum total cost of production. Realizing the importance of timing, Dowell has placed new emphasis on the study of decline curves and formation energy records to help you decide **when** to fracture each well.

Ask about how these Dowell planning steps can be used to help you increase profits from your frac jobs. Dowell services and products are offered in North and South America, Europe, North Africa and Iran. Dowell, Tulsa 14, Oklahoma. *DOWELL SERVICE MARK

SERVICES FOR THE OIL & GAS INDUSTRY

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

News

JULY DEMAND JUMPS

For July, oil demand rose 7% above 1960, Chase Manhattan Bank reported. Total for the year to date is 0.2% up from last year. Imports are up 5% in 1961, domestic production rose 3%. Biggest change is in crude oil imports on West Coast — 16% higher than 1960.

WEST COAST IMPORTS UP

Interior Secretary Udall ordered an increase in crude oil imports for the West Coast. Oil Imports Appeals Board had already restored Texaco and Nish-Paul imports. West Coast imports were reduced in December by former Secretary Seaton by what Udall called a "procedural error."

NAMED OIL IMPORT HEAD

J. Cordell Moore of Washington, D. C. has been appointed Oil Import Administrator by Interior Secretary Udall succeeding Lawrence J. O'Connor, Jr., new FPC commissioner. A career employee, Moore had been director of the Division of Security, Office of the Secretary, and a staff director of defense mobilization of Interior Department.

JERSEY SUES USA

Jersey Standard filed a suit in U.S. District Court aimed at upsetting the Government's method of allocating crude oil import quotas. If the purpose of the program is to stimulate domestic oil exploration and production, Jersey contends there is no justification for present unequal treatment of refiners. The scale is from 3.7% of runs for big refiners to 11.1% for smaller ones.

SINGAPORE PLANT OPENS

Singapore's first refinery, a 20,000 b/d Shell plant, went onstream ahead of schedule. Two Japanese concerns joined to build another. What's the attraction at Singapore? Pioneer status was granted – income tax exemption for 5 years and duty-free construction material.

GAS LINES INCOME UP

Profits are up but the margin is taking a beating for interstate natural gas pipeline companies. For a 12-month period ending May 1961 earnings were $330,848,450, an increase of 5.4% over a year previous. Operating revenues, however, rose 11.2% to $3,678,527,571, according to FPC.

PLAN HELIUM PLANTS

Helex contracted with Interior Department to sell helium extracted from natural gas for $11.24/Mcf. Panhandle Eastern Pipe Line, Cities Service, and others plan to build plants, sell crude helium to government. Kerr-McGee, which will build a plant at Navajo, Arizona, expects to sell to commercial market instead of government.

News

ESSO PRICES LIBYA OIL

First posting of Libyan crude was $2.21/bbl. Esso International established the price on Zelten crude when the new 30-in., 100-mile pipeline to the Mediterranean coast was completed. The oil is 39.0 to 39.9 API gravity.

TANKER STRIKE REPEAT?

"Cooling-off" period invoked June 26 by President Kennedy in shipping strike could resume after mid-September. The Taft-Hartley procedure calls for 80 days return to work. National Labor Relations Board ruled last month that a foreign-owned ship operated with U.S. company in U.S. commerce is subject to American labor laws. This may influence decision of seamen's union (85,000 members), which ask for the same power on tankers.

OIL AIDS NIGERIA

Exports of Nigerian oil reached 20,000 b/d and may go to 60,000 b/d by the end of 1961. Mr. R. P. R. McGlashan, managing director of Shell-BP Nigerian company, said, at the opening of the firm's new headquarters, that Shell-BP had so far spent $200,000,000 in Nigeria. Federal Prime Minister, Alhaji Sir Abubakar Tafawa Balewa, expressed his appreciation of the confidence shown by this investment in his country.

PETROCHEMICAL CORN

There is danger the federal government may subsidize uneconomic and illogical raw materials for chemicals, said J. E. Wood, president of Enjay Chemical Co. U.S. Agriculture Department announced a plan to sell government-owned corn (15,000,000 bushels) for industrial alcohol. "Unless such moves are opposed tomorrow's petrochemical plant could be on a farm in Iowa."

OIL CONGRESS MOVES

Sixth World Petroleum Congress organizations have moved offices to Glockengiesserwall 2-4, Hamburg 1, Germany. The German Committee for the Organization of the Congress is under the chairmanship of Dr. Ing. G. Schlicht, head of DEA. Dr. Gerhard Brendel, also of DEA, is general secretary. Prof. Dr. Carl Zerbe will handle scientific preparations.

DANISH PLANT READY

Denmark's first integrated refinery — Dansk Veedol (Tidewater) 20,000 b/d plant — will go onstream soon, reports Robert M. Hunt from Kalundborg. Dansk Veedol has acquired 40 service stations from Lolland-Falsters.

RESEARCH RESULTS

Texaco has developed a new motor that runs efficiently on any type of fuel and gives almost twice the mileage. Potential first customer: Uncle Sam. . . . Esso Research has designed a robot, resembling a small army tank, to prepare and paint smooth metal surfaces both vertically and horizontally at a speed of about one-half a foot a second.

News

D & D TO OBSERVE 10TH

Ten years ago Association of Desk and Derrick Clubs held its first convention at Houston, Texas. Delegates will go back to Houston September 22-23 for the tenth anniversary meeting, announced Mrs. Bettie Conley, president. Speakers include E. Clyde McGraw, president of Transcontinental Gas Pipe Line, and Miss Gladys Watford, past president of ADDC.

NEW R. R. COMMISSIONER

Texas oil men approved when Ben Ramsey, elected six times lieutenant governor, was named to the Railroad Commission, regulatory agency that handles oil proration. He fills the vacancy created by the death of Olin Culberson.

SEVEN IN ANTITRUST SUIT

In a civil antitrust complaint filed by Justice Department seven companies were charged with controlling patents on jet perforating. Defendants are Borg-Warner, Dresser Industries, Halliburton, McCullough, Pan Geo Atlas, Schlumberger, Jet Research Center. Cited as alleged co-conspirators were Gulf R & D and others unnamed. The seven are said to have 95% of a $26,000,000 market.

IKARD STEPS INTO API

Congressman Frank W. Ikard (D.-Texas), Wichita Falls, will be executive vice president of API, with headquarters in Washington. He may be groomed for API presidency, now held by Frank Porter. Although considered a liberal Democrat, Ikard has favored the petroleum industry in his six terms.

NEW AFRICAN REFINERY

A $28-million refinery producing petroleum products now used in the Federation of Rhodesia and Nyasaland (Southeast Africa) is expected to go onstream by December 1963. Refinery is to be erected by American Independent Oil Company (AMINOIL) in cooperation with local distributors.

BOUGHT AND SOLD

Pure Oil has acquired Cascade Petroleum, Fort Worth, in exchange for stock valued at $6,000,000 . . . Honolulu Oil under certain conditions would consider sale to Tidewater and Pan American without Internal Revenue Service approval, the company reported . . . Calvert Exploration and Mid-American Minerals will jointly buy Blackwell Oil and Gas, Tulsa, for $4 3/4 million . . . Shell bought all Bishop Oil assets for $5,626,700 . . . Socony Mobil acquired 90% of O&M Kleemmann, Ltd., petrochemical processing and marketing firm in England, for $20,000,000. Mobil Chemical proposes to build a $24,000,000 urea plant in Formosa.

PRORATION THE SAME

Texas R.R. Commission continued its 8-day producing schedule in September for the fifth consecutive month. Commissioner Thompson told President Kennedy Texas could double output. New Mexico again set an allowable of 34 b/d for southeast, 70 b/d for San Juan fields.

Petroleum Management®

September, 1961—No. 10, Vol. 33

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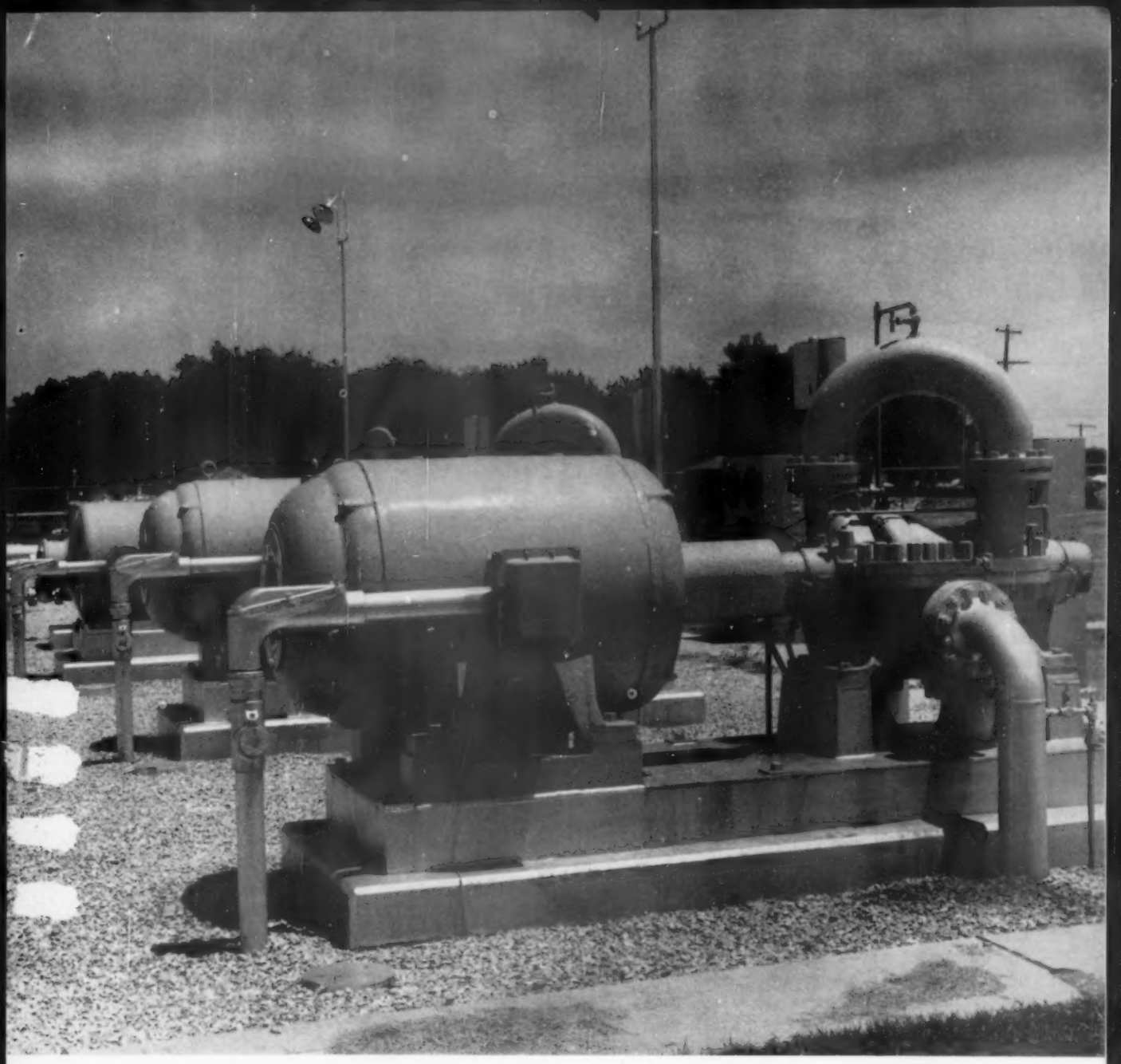

And these 1,650 horses pumped happily ever after on U. E. P.*

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In converting this mainline crude oil station to efficient purchased electric power five electric motors totaling 1,650 horsepower were applied. Electrification is complete even to the 8 electrically operated valves. Consult your local Utility Electric Power Company today about converting your operation.

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List of P. E. P. A. members will be furnished on request.

Course of Oil

How to Nationalize Petroleum

You're a political "liberal," which means you think stronger federal power is best and is inevitable. You are appointed to a Washington bureau, along with many new bureaucrats who hold the same opinions.

You already know the most important instrument of economic power is control of the chief energy source — petroleum. How do you master this industry? It's much simpler than you think. Here are some directives but they are far from exhaustive.

1. Never let the word "nationalize" cross your lips. Always say "government regulations for protection of industry and consumer."

2. Take advantage of intra-industry divisions: Majors vs minors, producers vs distributors — there are dozens. You can't miss hitting one no matter who's listening. You can be sure he would rather the government took over than his industry competitor.

3. Justice Department can have a field day. It doesn't have to win a case. It can file antitrust charges against seven oil well servicing firms which have 95% of a $26 million market. This averages $3½ million a company. It's kinda piddling but every little thing helps.

4. Federal Aviation Agency can force drilling operators to apply to Washington 30 days ahead to get a permit to move or operate rigs higher than 150 feet. If permits get held up — what do they expect from a federal bureau? FPC almost required drilling permits but this more indirect tactic allows FPC to work on other regulations.

5. Use imports as diversion tactics. When historical importers slow their complaining, allow refiners to increase their allotment. When refiners are half-way quiet, put producers on the importing list. Don't ever mention a plain, old-fashioned tariff — it's too equitable and would knock the import bureaucrats out of jobs.

6. Here's a gem of an idea. Internal Revenue Service can refuse to pass on possible sales of oil and gas reserves. Let companies make a deal if they want to and gamble on the answer. Then IRS will come up with its judgment of whether the sale will be taxed as capital gains or as current income. That'll shut in these free-wheeling independents.

7. Federal Power Commission can do a better job putting a squeeze on natural gas producers. Reserves did drop from 30 years supply to 21 years, but more headway can be made. Don't let a transmission company file a new rate case if it has one pending. Then by delaying decision on rate cases, you can bankrupt a company faster than you realize.

These seven directives are only the beginning. You don't have to take petroleum over to nationalize it. You have the power to run it but the companies take the blame for failure.

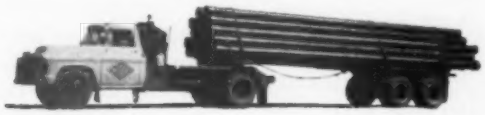
And keep on extolling free enterprise while you lock it up.

— *Ernestine Adams*

Congrats and $25 for this quip to C. E. Curtis, Dailey Oil Tools, P. O. Box 1432, OCS, Lafayette, Louisiana.

Lone Star, the nation's most modern steel plant, is still growing . . still adding new facilities . . augmenting capacity . . keeping quality always at an exacting API high.

These are the reasons Lone Star is Joe Roughneck's solid source of supply for API casing, tubing and line pipe.



Neighbor, wherever you are, specify Lone Star and we both get a good deal.

Lone Star STEEL COMPANY

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Profile

You recall Horatio Alger's heros when you take a look at Algur Hurtle Meadows' career. He had the courage to try any job when he was a youth and setbacks turned into opportunities.

Like the time he and a friend were hired as cooks in the Merchant Marine at New Orleans and didn't know they had to have passports. The ship sailed without them but they heard of oilfield activity in North Louisiana. By pawning most of their belongings they got to Shreveport and Standard Oil Company hired them—Al in the office because of his business schooling.

Son of a country doctor in Vidalia, Georgia, Al Meadows graduated from high school and went to a business college, then attended Mercer University, both at Macon, Georgia. After his sophomore year a cousin offered him a job at his Ford agency in Metter. Here a new friend persuaded him they should see the world.

They did see Jacksonville, Florida, and from there they went to New Orleans and were blocked in their attempt to be Merchant Marine cooks. Since Al knew nothing about cooking, it was a kindly fate that stepped in.

Al did well with Standard. He settled down, married a Shreveport girl, Virginia Garrison Stuart, and might be there yet except for his penchant for learning.

"What is the most important thing that ever happened to you in your career?"

The answer of the tall, handsome man was unexpected. "Getting a law degree."

Getting it wasn't easy. Especially as he first had to help organize the law school. When he was working for Standard he took an evening course in commercial law taught by a young Harvard lawyer. In the same class was Ralph G. Trippett and the two became friends and later business partners.

Meadows and others of the class were so enthusiastic about their brilliant teacher that they helped establish a fully accredited law school in Centenary College with their teacher in charge. In 1928 Meadows passed the Louisiana bar examination and received his law certificate.

A uniform small loan bill became law about that time and Trippett and Meadows formed the first loan company under the new act. Success was immediate. Soon they had eight firms in Louisiana and Texas cities. Then one day in 1933, when the partners were worrying about collecting loans of some $2 million, J. W. Gilliland, an oil operator, came into the office for a loan on East Texas oil. Two years later Trippett, Meadows and Gilliland formed the Gilliland Production and Refining Company, which became General American Oil Company of Texas. The young company had a struggle in the fierce competition of East Texas and Trippett left the firm. When things got really shaky, Meadows came up with an idea that rescued the capital-poor company — interest bearing oil payments. It's a common practice today but hadn't been tried then.

The idea kept the company afloat but troubles weren't over. Gilliland retired in 1941 and for the first time, the youngest of the trio became president. The fight to keep his organization going required all of Meadows' ingenuity. You'd think he'd have plenty of worry wrinkles but he hasn't. "I've had a charmed life," he says.

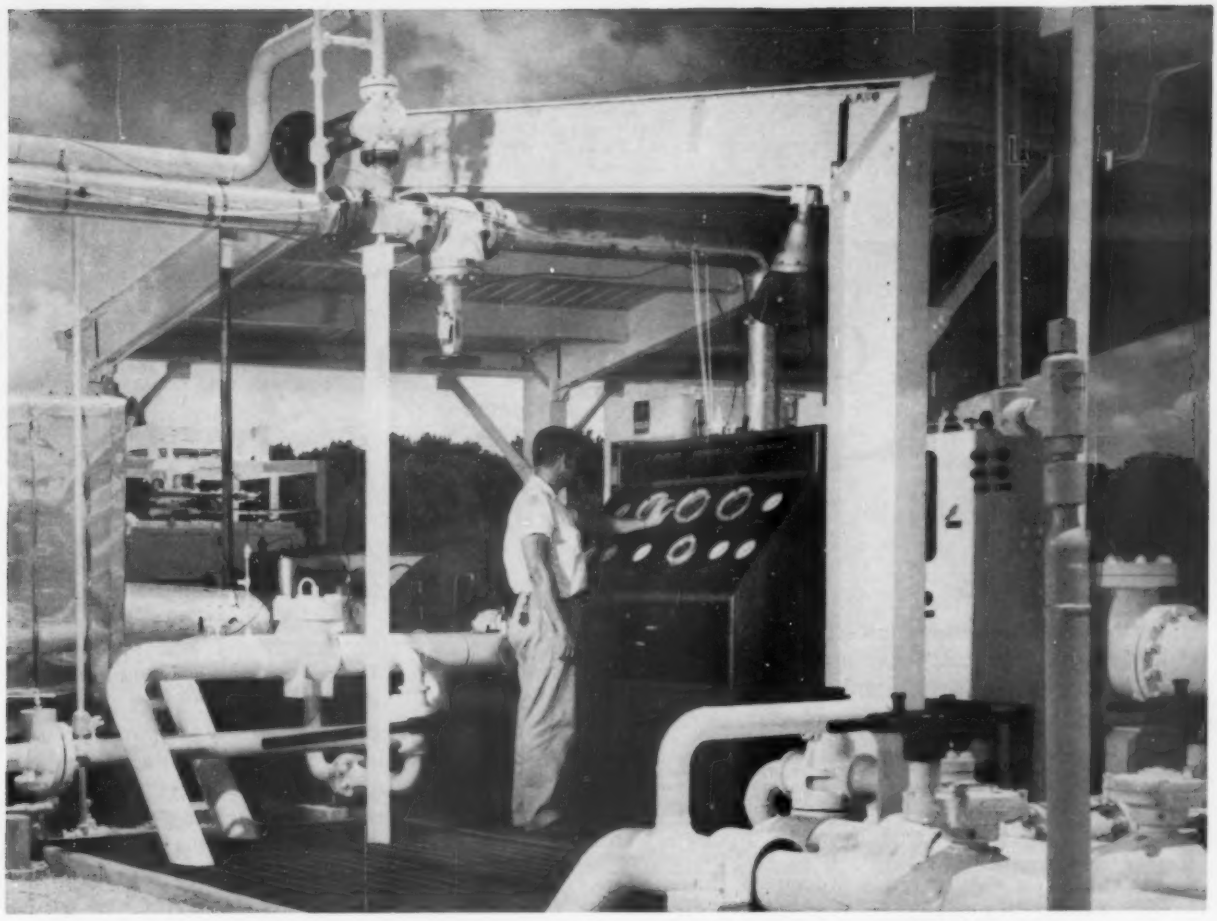
"What is your recipe for a charmed life?"

"Faith," he replies. Faith, optimism, belief in yourself and others — whatever you call it, every successful oil man has the quality.

The bad years were weathered. Today Al Meadows has an office atop the fabulous Meadows Building in Dallas, a far cry from the shack in East Texas. His son, the only child, has an investment company and his offices are in the building, also.

Meadows is a favorite in Spain which his company has explored for ten years. His distinguished art collection is centered around Spanish artists, including such old masters as El Greco, Velasquez, and Goya. General American — with net worth of $100 million — is fully integrated now and its operations reach into Canada and Egypt as well as Spain.

■



Trunkline uses Solar Gas Turbine compressor in pipeline station

Currently "on-line" at Trunkline Gas Company's Cypress, Texas, pipeline compressor station is an 1100 hp Solar *Saturn* gas turbine-driven centrifugal compressor set. In this application, it pumps up to 60 million cu ft of natural gas per day.

At Cypress, Trunkline is helping to pioneer a new concept: the use of a high-speed, turbine-driven centrifugal compressor in the low-volume range. Traditionally, reciprocating equipment has been the most practical in the range from 75 to 1000 inlet cu ft per minute at up to 1500 lbs pressure.

However, the availability of industrial high speed drivers, such as the Solar *Saturn* T-1000 gas turbine engine, has provided the impetus for Solar to design and build a line of efficient, long-life centrifugal compressors for this range.

The Trunkline installation is 1/10th the size of conventional compressor sets, costs an estimated 2/3rds as much to install and will run on a variety of fuels. At Cypress, for instance, the Solar compressor set runs on natural gas from the line. It would also run on gasoline, diesel fuel, kerosene or LPG fuels.

Another advantage of Solar compressor packages is the fact that a complete turbine-driven 1100 hp unit weighs less than 10,000 lbs and occupies under 300 cubic feet of space. It is easily portable.

Solar compressors are also ideal for field boosting. One *Saturn* turbine-powered set will deliver as high as 100 million cu ft per day. A unique modular concept of interchangeable compressor staging allows quick, easy field changes to accommodate changing pressure and flow requirements.

Solar's industrial turbomachinery is designed for rugged use. Solar turbines start instantly without warm up and are ideal for remote or unattended operation. Ranging from 50 to 1100 hp, they can deliver more power per pound than conventional engines for pumping, electric power generation, oil well servicing and other prime mover requirements.

For more information about Solar turbomachinery, write Dept. J-136, Solar Aircraft Company, San Diego 12, California.

SOLAR

A subsidiary of International Harvester Company

Conference Table

What People Cost

Ohio Oil Company shows the rise in payroll and capital investment per employee in the last 15 years. For other employment news see "People in Petroleum" in this issue.

	Approximate annual payroll	Approximate per employee	Approximate property, plant and equipment	Approximate investment per employee
1945	$15,500,000	$2,800	$273,000,000	$49,000
1950	27,000,000	4,500	361,000,000	60,000
1956	42,000,000	6,300	549,000,000	83,000
1957	44,000,000	6,700	602,000,000	91,000
1958	45,000,000	7,000	626,000,000	97,000
1959	56,000,000	7,400	690,000,000	91,000
1960	57,000,000*	7,500*	734,000,000	97,000

*Benefit plans added 30 cents for every dollar of basic pay in 1960.

Point of Less Return

Many states will collect fewer dollars from taxes on gasoline than they expected to because high gasoline taxes have become self-defeating, said Frederick B. Hufnagel, Jr., Sun Oil vice president. This will cause budgets for spending on state highway project to be thrown out of balance. Federal Bureau of Public Roads released figures that bear out this trend, he said.

State-Owned Oil Companies Meet

State-owned petroleum corporations of Latin America met in Venezuela in June. Recommended as principal goals of their organizations were that they: (1) Provide necessary means for social and economic development of their countries; (2) assist in development and diversification of other national industries; (3) provide increases in per capita income and social progress; (4) endeavor to provide necessary domestic marketing control of petroleum and by-products; (5) contribute to the normal development of foreign markets and exporting countries.

The Congress was called by Venezuela's Ministry of Mines and Hydrocarbons and was attended by representatives from Argentina, Brazil, Bolivia, Mexico, Colombia, Uruguay and Venezuela.

You will notice that no mention of profit as such is made. Ironically, capital for the state-owned companies comes from those economic units which pay taxes to the state out of profits. In all instances of which we are aware, state-owned and privately owned competition in one industry is unfair, inefficient and presents a false front to the public, which has neither the time nor the background to place blame or approval.

Settin' a Spell With Sam Mallison

The rocking chair title of Sam Mallison's new book, "Let's Set a Spell," leads you through some entertaining gossip in the political circles of West Virginia. There are 330 pages of highly entertaining people and events that only a crack political reporter with a golden pen could write.

Most people in the petroleum industry know Sam Mallison, who left political analyzing many years ago to head public relations for Plymouth Oil Company. He wrote one of the best oil industry books, "The Great Wildcatter," a biography of Michael L. Benedum, who died in 1959.

"Let's Set a Spell" is attractive for practical reasons. It's the kind of book you can leave in the guest room, the kind to send to a sick friend, the kind to enjoy yourself, whether you have 15 minutes or an hour to read.

You can order copies by mail from Education Foundation, Inc., P. O. Box 1187, Charleston, West Virginia. Price is $3.40 per copy cloth bound and 95¢ paper bound.

Good Wells Make Good News

Recent Frac Treatments That Solved Special Production Problems

September, 1961

Knotty production problems can often be solved by Dowell fracturing treatments. Dowell has many modern tools to help both in planning and in performing frac jobs, whether routine or complex. Some of these advancements include the Frac Guide*, computer calculations and fracture conductivity tests. Here are four recent examples of Dowell frac jobs that solved special production problems:

- **Ashtabula County, Ohio** (New Oil Well) Pay zone was the low permeability, low porosity Medina sand. Perforations were from 3760 to 3765 feet. Other wells in the area, given small frac jobs, have been poor producers with rapid decline rates. Dowell engineered a treatment with the aid of the Frac Guide. 37,000 gallons water with FLA* fluid loss additive carried 66,000 pounds sand. Injection rate was 50 bpm. *Before treatment, well made show. After treatment, production was scheduled at 160 bopd through a 1/16th-inch choke.*

- **Andrews County, West Texas** (New Oil Well) This well had been abandoned after previous treatment efforts had failed to result in commercial production. Several cement squeeze jobs had been performed. Perforations into the Devonian were from 12,040 to 12,045 and from 12,063 to 12,073 feet. Dowell used Acid Petrofrac* fracturing service. 50,000 gallons acid-oil emulsion and 13,000 pounds sand were injected down tubing at pressures up to 7500 psi. *After treatment, well tested 463 bopd flowing through a 24/64th-inch choke.*

- **Muhlenberg County, Kentucky** (New Oil Well) Dowell used Abrasijet* abrasive jetting service to perforate into the Paint Creek sand between 1909 and 1920 feet. Well was then treated down casing. A spearhead of 1000 gallons kerosene with Freflo* surface active agent was followed by frac job. 17,000 gallons lease crude, 20,000 pounds sand and 800 pounds of a fluid loss control agent were used. *45 days after treatment, well was still making 160 bopd. An offset shot with nitro made 80 bopd.*

- **Hutchison County, Texas Panhandle** (Old Oil Well) This is one of the many shallow wells completed into the Dolomite of the Panhandle field. The problem was to fracture several zones in stages. The pay has very low structural strength. Later stages of a frac job are likely to break past the cement bond into the zone fractured first. Dowell engineers designed a treatment that employed a gel diverting agent followed by permeable ball sealers. *Operator reported that the production increase was 30 percent above increases obtained from previous treatments on other wells in the area.*

Let a Dowell engineer help you select a treatment designed to solve your production problem profitably. Dowell services and products are offered in North and South America, Europe, North Africa and Iran. Dowell, Tulsa 14, Oklahoma.

*Dowell Trademark

SERVICES FOR THE OIL & GAS INDUSTRY

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

One Stop for All

Pure Oil is trying out a new merchandising program in its service stations. Montgomery Ward catalog sales agencies are being established in three Pure stations as an experiment by both companies. Pure thinks this may attract additional patronage and Montgomery Ward feels that the service stations offer customers a place to park and quick convenient service.

Poor/Rich States Farce

What are some of the weaknesses and contradictions in federal aid programs? Delaware Senator John J. Williams' answer was given on the floor of the Senate. Here are excerpts: "(These) bills define which are the poor states and which are the rich states and set out that the rich states can afford to help pay for the poor states. But the states keep switching sides.

"For instance, Pennsylvania will receive, under the extension of unemployment compensation benefits bill, some $85 million in benefits and will pay its proportionate part of the cost of the bill, $70.7 million. That gives Pennsylvania $14.3 million, which the then-defined richer states are asked to provide.

"Which were the rich states on March 16?

"Tennessee was one. The state of Tennessee contributed $7 million more than it received to help underwrite the expenses of the unemployment compensation benefits.

"Some $3½ million was contributed by Mississippi to help the poor state of Pennsylvania. Another rich state was Alabama. Alabama contributed an extra $2.2 million.

"Now the (aid-to-education) bill lists Alabama as a poor state needing federal assistance. Today we find under the definition of the bill before the Senate that Pennsylvania is listed as one of the rich states which can help Alabama meet its educational problems. This is a complete reversal in 3 months.

"In other words, money was taken from the South and brought to Washington, D. C., under the terms of one bill and now under the terms of this bill, money from the North is to be returned to the South.

"This is not an uncommon situation.

"The operation is like a merry-go-round — only it is more expensive. As the money goes through the city of Washington and is siphoned off to these states, there is taken a political brokerage, or a cost which is necessary to maintain the bureaucracy which administers these programs.

"That is the reason we have here in Washington an ever-expanding bureaucracy. New programs mean new office buildings, more bureaucratic jobs, more patronage for the politicians, and more controls and taxes for the American taxpayers.

"All we had to do was let (the states) keep their own money and they could have financed their own unemployment and educational problems.

"I for one am growing tired of helping states which make no effort toward financing their own educational system or to take care of their own unemployment problems, and which are always asking the federal government for support."

— From "The Bulletin," Standard of California magazine; C. R. Lyman, editor.

Starting Salary for Engineers

Engineering graduates for 1961 at Illinois Tech received an all-time high in average beginning salaries — about 5% more than in 1960. The graduated engineer started to work for an average of $550 a month, compared with $525 average the year before.

It Isn't as Simple as ABC

D. L. Connelly, president of Mid-Continent Oil & Gas Association, stated that the so-called "ABC" transaction has been employed by the petroleum industry for many years for completely disposing of producing properties. This is the tax treatment the Internal Revenue Service announced that it was reconsidering.

Since the early 1940's, these transactions have been submitted to the IRS for review as to their tax consequences. The IRS has consistently held, under both the 1939 and 1954 Codes, that proceeds received by the seller for his properties were entitled to capital gains treatment. Probably more than a thousand rulings have been issued to individual taxpayers to this effect over an approximate 20-year period.

Connelly emphasized that the "ABC" transaction is not a new development, and has been recognized by both the government and industry as a common method of financing the sale and purchase of oil and gas properties.

To Fill a Gap

P. W. Bishop, head curator of department of Arts and Manufacturers, Smithsonian Institution, reminds us that petroleum development has been exhibited for some time in its Arts and Industries building. We reported an oil exhibit to be developed in the new Museum of History and Technology and left the impression that this was the first petroleum presentation at the Smithsonian.

"WE CAN MOVE MIGHTY CHEAP DIRT WITH A D7D"

HARVEY W. JONES, JONES CONSTRUCTION CO., NATCHEZ, MISS.

This is one of two Cat D7 Series D Tractors used by the Jones Construction Co. for site preparation and general construction work. Commenting on their ability to move cheap dirt, Mr. Jones said: "The D7D is the right size tractor for our oil field and other contracting work. It's large enough to do the job—and small enough to be easily transported. We're well pleased with the trouble-free operation the past year. A D7D can't be beat!"

How about you—are you moving dirt as cheaply as you can? An older model tractor that is paid for may seem to move dirt at low cost. But in reality it could be losing as much as it earns. It just can't move earth as cheaply as a new machine. Why?

The D7D, for example, is more powerful and easier to maintain than predecessor models. Its ability to do more work and do it for less cost could greatly increase your profit potential. You can check this by comparing the production and costs of your present equipment with the D7D. For the full story and a demonstration with measurable results, see your Caterpillar Dealer. He has some eye-opening facts. He'll lay them on the line for you!

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

INCREASE YOUR EARNINGS WITH A D7D

D7D MONEY-EARNING FEATURES

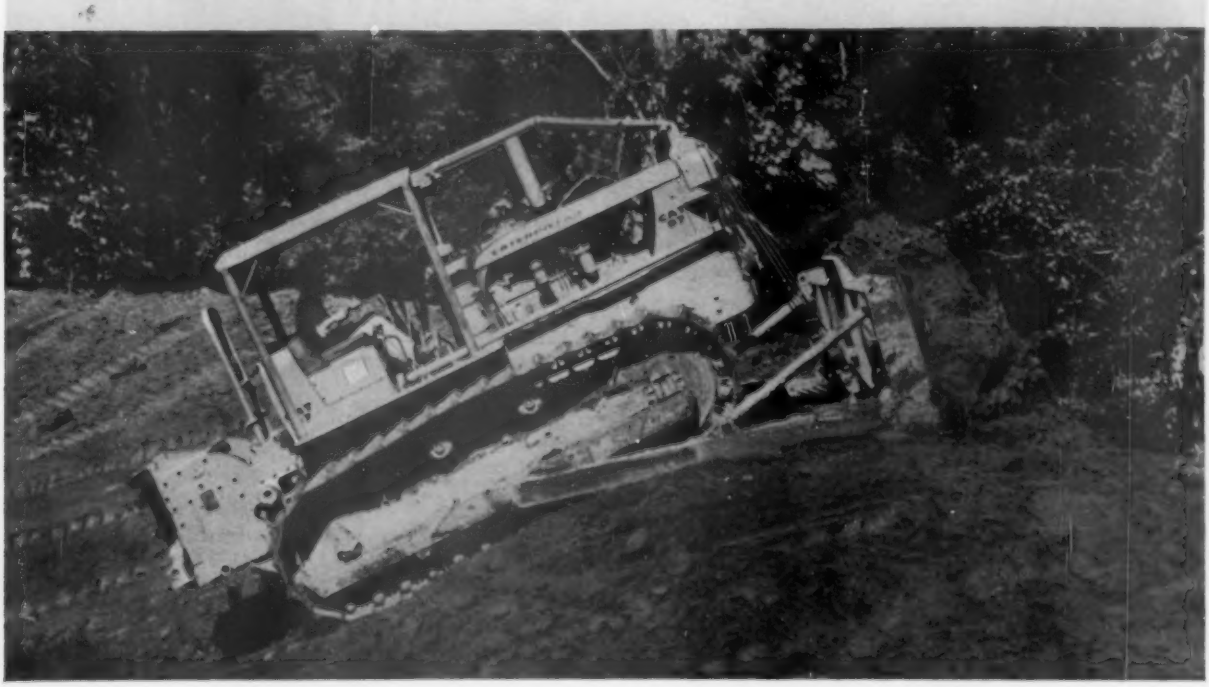
TURBOCHARGER—offered only on the D7D in its class. Addition of this unit has boosted HP to 140 at the flywheel, almost doubles lugging ability, delivers more efficient combustion for important fuel savings.

DRY-TYPE AIR CLEANER—removes at least 99.8% of dirt from engine intake air under all conditions. Materially lengthens engine life by protecting it from abrasive dust. Can be serviced in five minutes.

POWER TRAIN—stronger and better than ever, with final drive gear teeth strengthened 50%. Another factor increasing drive train life: an improved lubrication system for transmission, bevel gear and pinion.

ROLLERS—no more costly down time from improper or missed lubrication. Exclusive floating ring seals keep constant pressure on seal surfaces—oil stays in, dirt out. These rollers never need attention until rebuild time.

OIL CLUTCH—another exclusive in the D7D class. Users report up to 2000 hours of adjustment-free service on even the most severe applications. Clutch replacement almost unheard of!



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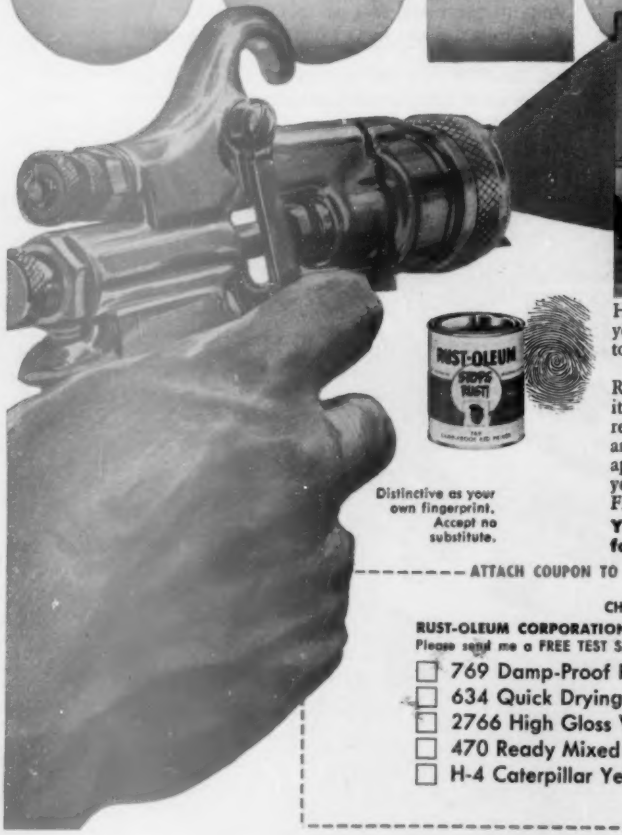
COLORS



Distinctive as your own fingerprint. Accept no substitute.

How much does rusty equipment cost *you*? With Rust-Oleum, you STOP RUST—and you match original equipment colors, too, for long-lasting protection!

We want you to see for yourself how *easy* it is to use Rust-Oleum . . . actually take the brush and see how smoothly it works, how it dries to an *attractive, high-gloss finish* that resists sun, fumes, rain, heat, snow, salt air and salt spray, and blowing dust and sand. And the same formula can be applied by brush or spray. Just check the coupon for the color you want . . . and attach it to your business letterhead for a FREE TEST SAMPLE. No cost or obligation.

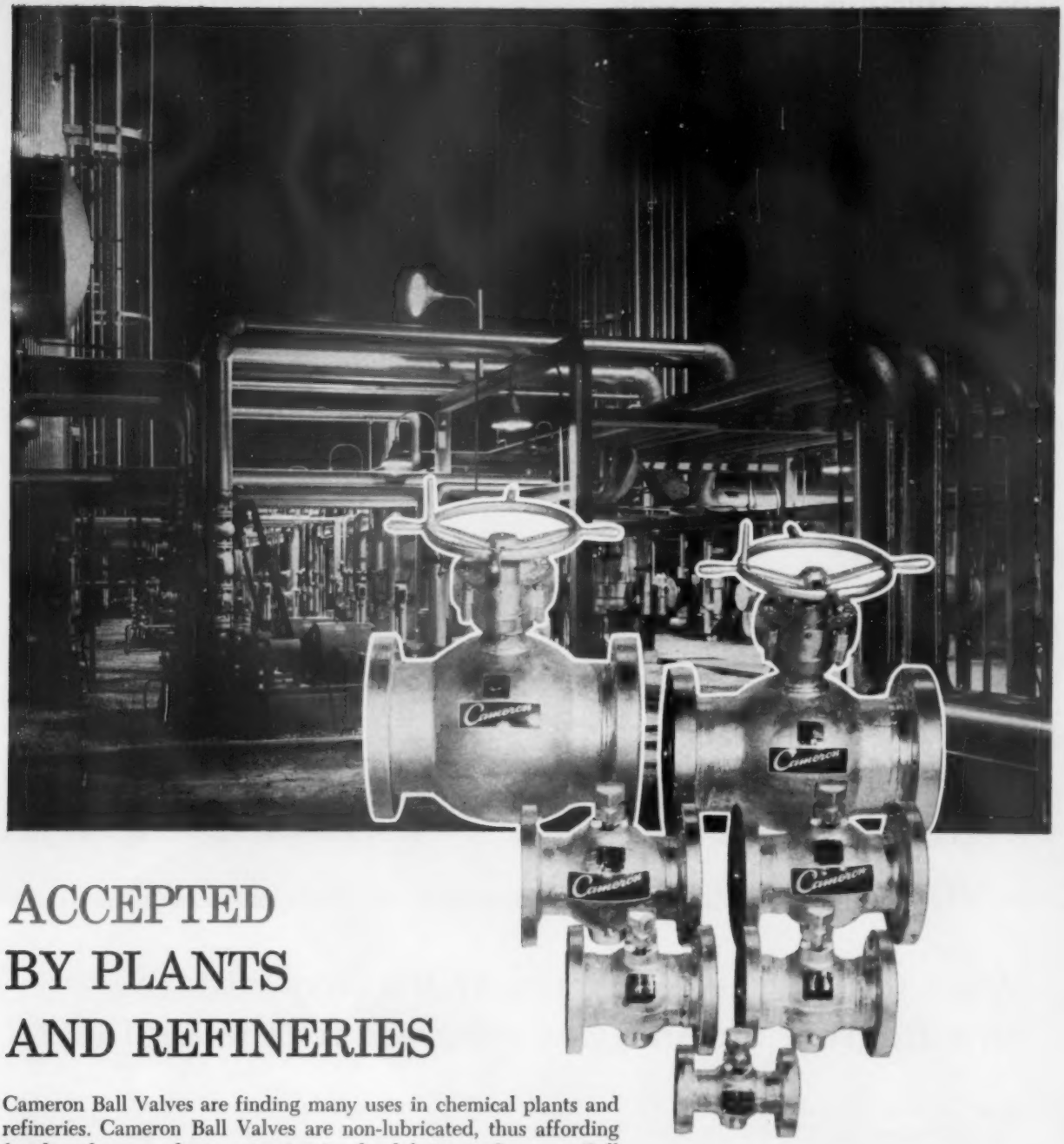
Your Rust-Oleum Distributor maintains complete stocks for immediate delivery.

ATTACH COUPON TO YOUR BUSINESS LETTERHEAD FOR FREE TEST SAMPLE

CHECK COLOR TO MATCH YOUR EQUIPMENT

RUST-OLEUM CORPORATION, 2587 Oakton St., Evanston, Ill.
Please send me a FREE TEST SAMPLE in the color checked:

- ☐ 769 Damp-Proof Red Primer
- ☐ 634 Quick Drying Black
- ☐ 2766 High Gloss White
- ☐ 470 Ready Mixed Aluminum
- ☐ H-4 Caterpillar Yellow
- ☐ 722 Bethlehem Yellow
- ☐ 726 New Emsco Green
- ☐ 727 New Unit Rig Gray
- ☐ 724 Waukesha Gray
- ☐ 721 National Blue
- ☐ 723 Oil Well Orange



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Cameron Ball Valves are finding many uses in chemical plants and refineries. Cameron Ball Valves are non-lubricated, thus affording freedom from product contamination by lubricant. Cameron Ball Valves have no bonnets or glands to leak. They have bubble-tight shut-off without adjustment and require no maintenance. These features are especially valuable at plants and refineries.

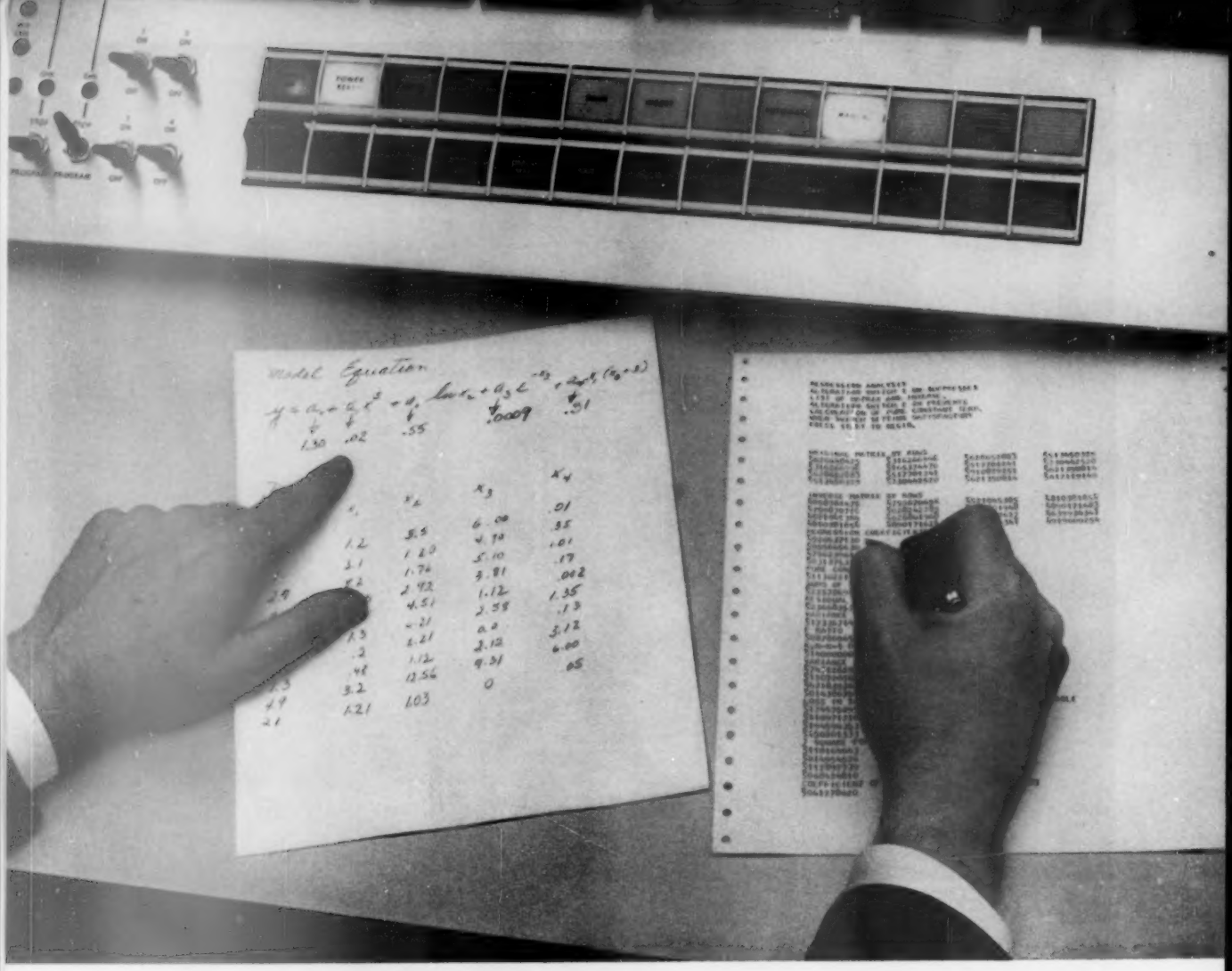
Cameron Ball Valves have been tested for three years in many types of service. The large volume of repeat orders attests to their savings for customers and their outstanding performance. They are compact, amazingly easy to operate and can be equipped with wrench, hand-wheel or power operators. Cameron Ball Valves are available in sizes 2" and larger, 150# ASA to 1500# ASA.

Have you checked on what Cameron Ball Valves can do for you?

Cameron

CAMERON IRON WORKS, INC.
P. O. BOX 1212 HOUSTON, TEXAS

CAMERON BALL VALVES



Want to find the coefficients? It's easy with the new Regression Analysis program for the IBM 1620

Here's another program offered free-of-charge to users of the IBM 1620 Data Processing System. It gives you the kind of results you might expect only from a much more expensive computer. But users of the 1620 know that its low rental cost is deceptive. The 1620 packs *more computing power per cubic inch* than any other computer in its size range.

The Regression Analysis program is a good example. Suppose you want a fit for production purposes. If you employ more than two variables you probably have difficulty visualizing the representation of your data. If linearity is not the case, you must often guess blindly at a polynomial of high degree, accept or reject the fit with something approaching a sixth sense, and either try again or settle for the results you have.

The new Regression Analysis program lets you handle expressions containing up to *24 variables*. If you have the even more complicated task of handling many dependent variables, the program will generate regression coefficients with a maximum number of dependent variables not exceeding one-half the number of independent variables.

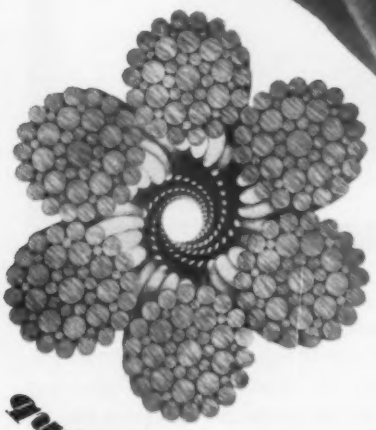
This program will also fit non-linear functions and hyper-surfaces. Compare this performance with that of any other computer in the 1620's price range.

A basic 1620 installation rents for just $1600 per month. For details, contact your local IBM Representative.

IBM's 1620 is a compact desk-size computer.

IBM®
DATA PROCESSING

We put a lot of work into it — You get a lot of work out of it



Quality inside and outside

Here are two "close-ups" of Roebling Royal Blue Wire Rope which show in part where your savings come from . . . uniformity of structure. Invisible, but equally important, is Royal Blue's *extra* high tensile strength. All the way through, Royal Blue pays off for you on every kind of wire rope job. Find out more from your wire rope distributor, or write for free booklet to Roebling's Wire Rope Division, Trenton 2, New Jersey.

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Branch Offices in Principal Cities
John A. Roebling's Sons Division
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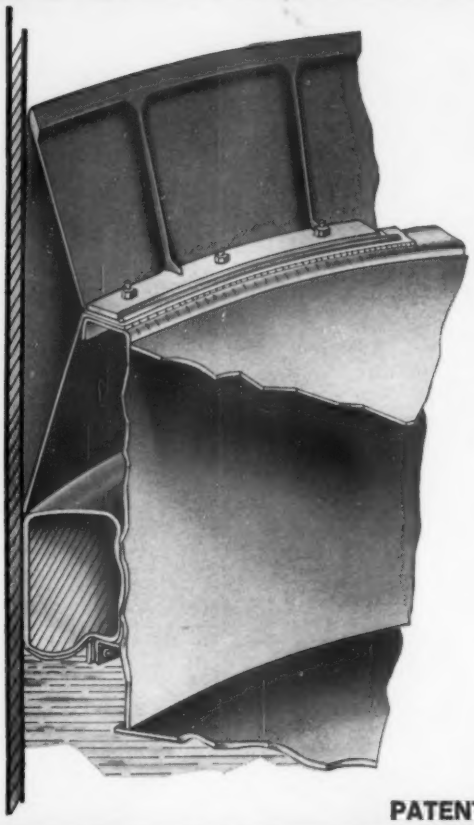
ALL FLOATING ROOF TANKS ARE FULLY EQUIPPED, **BUT...**

Only Tubeseal Has Lightning-Proof, Electro-Conductive Weather Shield



PATENTED

Tubeseal electro-conductive weather shields are an ***exclusive tried and proved development.*** They provide positive protection against lightning-caused rim fires. ■ How? By maintaining a *continuous* grounding bond between roof deck and shell—concentration of static charges is impossible. There has *never* been a lightning fire where any of the many hundreds of Tubeseal System Floating Roof Tanks are installed throughout the world—they're "lightning proof." ■ This is scientific and safe storage protection for the entire range of volatile products. Tubeseals can be installed on any of your tanks—new, old, riveted, or welded. You owe it to the future safety of your conservation facilities to investigate. Send for the Tubeseal Bulletin now—it could be important.

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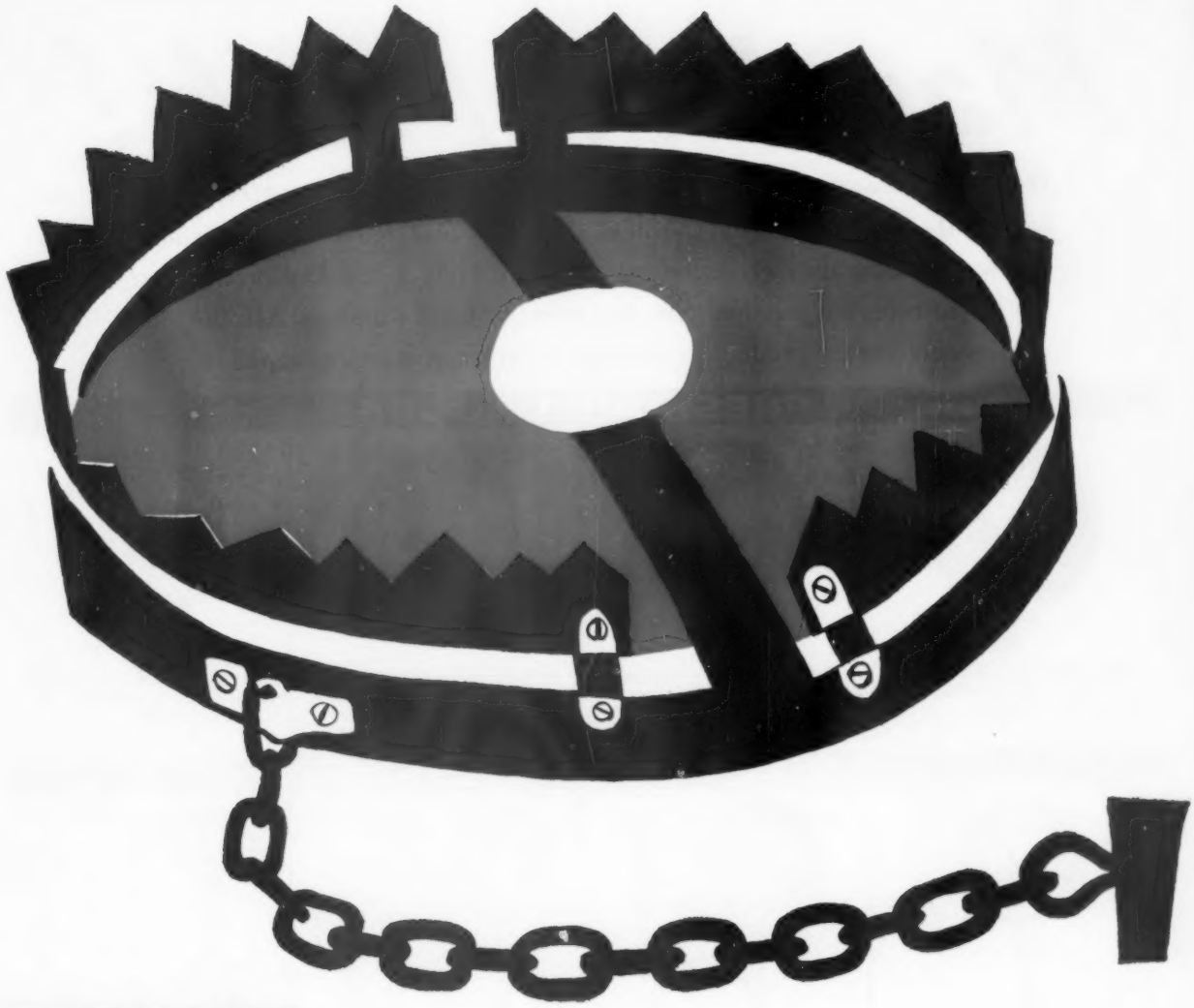

acts fast: There are times when a valve must shut off NOW! That's why you'll find Rockwell-Nordstrom valves in critical operations everywhere. With their smooth, fast quarter turn action and positive shut-off they're man's best friend in an emergency. It makes a lot of sense to use these same Rockwell-Nordstrom valves in all services—they cost no more. We'll be happy to send you complete information.

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If it's a pressure gauge, dial thermometer, or needle valve, Marsh makes it...makes it in every form to suit every need...makes it better in the opinion of thousands of discriminating users. Only a few key products are illustrated here, but hundreds are described in Marsh Catalogs. Ask for information covering the product or products in which you are interested.

PRESSURE GAUGES

"Mastergauge"—the world's most effective pressure gauge for extreme service.

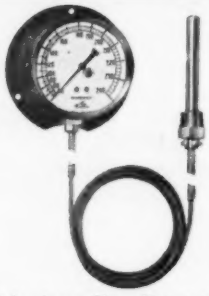
"Master-test"—"Mastergauge" quality in a gauge for services requiring high accuracy.

Quality series—second only to "Mastergauge" and "Master-test" for tough conditions.

Standard series—best moderate-priced gauge for run-of-plant conditions.

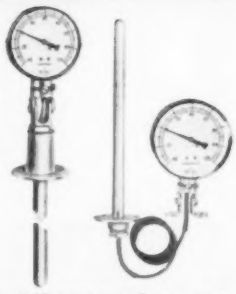
DIAL THERMOMETERS

Vapor tension thermometers—direct mounted type. Many sizes; ranges.



Distant reading thermometers—vapor-tension and gas filled types in many sizes; ranges.

Piping thermometers—specially designed for piping. Types for all purposes, including distant reading.



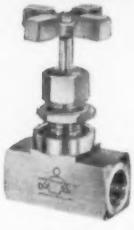
Duct thermometers—specially designed for all conditions including distant reading.

NEEDLE THROTTLING VALVES

Alloy steel—complete series of sizes and patterns. Pressures up to 10,000 psi.

416 Stainless steel—complete series of sizes and patterns in 416 stainless. Pressures up to 10,000 psi.

316 Stainless steel—complete series of sizes and patterns in 316 stainless. Pressures up to 6,000 psi.



Panel mounted—all valves—alloy steel, 416 stainless, and 316 stainless—available in panel mounted types.

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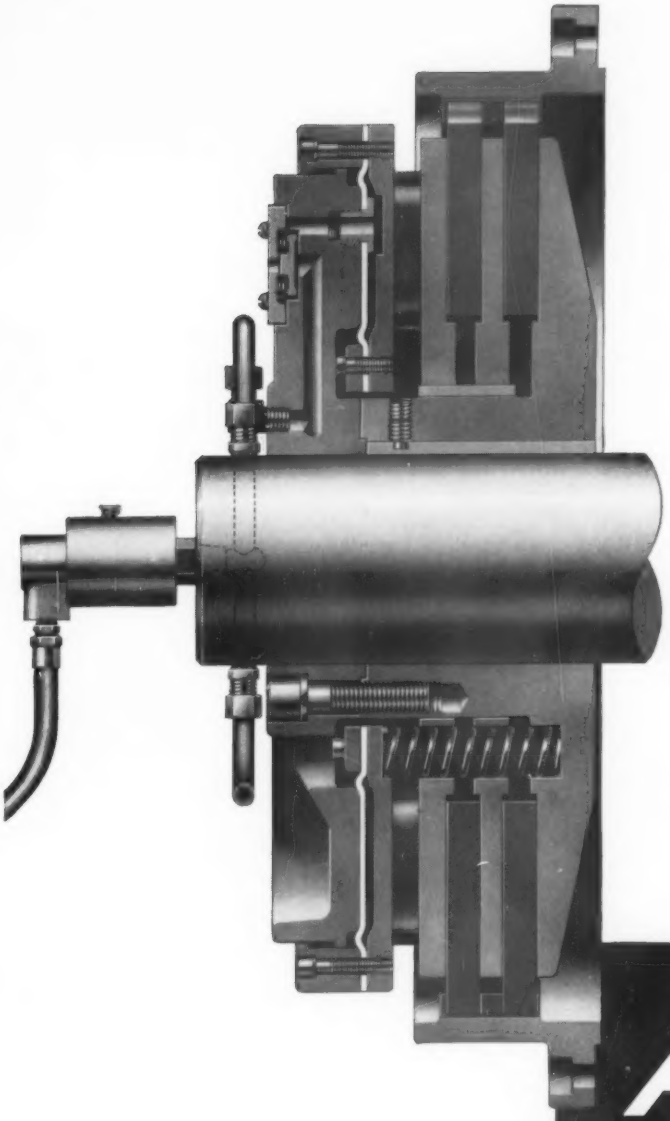

1. Quickest acting, most responsive air clutch available!
2. Finger tip control!
3. Built-in quick release valves! (Optional)
4. Requires minimum volume of air!
5. No adjustment necessary!
6. Internally ventilated — cooler operation!
7. Operates at air pressures up to 140 psi!
8. Most compact!
9. Interchanges with and can be used to replace Dodge or other mechanical clutches in existing installations.
10. Available from stock in single and double plate types. Capacities from 8.5 to 460 hp at 100 rpm at 80 psi.

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—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the *white* pages of your telephone directory, or in the yellow pages under "Power Transmission Machinery."

This air clutch, engineered to modern needs, provides maximum torque capacity in minimum space. Its operation requires less air, resulting in amazing sensitivity. It gives the operator split-second control—from "inching" to full engagement. Quick-release valves are built into the clutch itself, as optional equipment, for instant disengagement where such service is required.

The unique design of Air-Grip places the air seal disc at the end *farthest* from the pressure plates, which generate the heat inherent in clutch action. This combined with automatic internal ventilation, insures cooler operation and longer life under severest service. Call your local Dodge Distributor, or write for Bulletin.

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quality control tests make sure Youngstown line pipe won't fail in the field

Take the pipe and check the weld. Then crush an end. Burst a length. Pressure-test it hydrostatically. From ore to steel to final stenciled product, separate mechanical and visual inspections make sure Youngstown line pipe won't fail in the field.

Get Youngstown Electric Weld line pipe in sizes 6⅝" to 22" O.D. Get it in time and money-saving long lengths to 55 feet. Order Youngstown Seamless line pipe in sizes 2⅜" to 14" O.D., Continuous Weld line pipe in sizes ⅛" nominal to 4½" O.D. Get it fast, when and where you want it, through Youngstown District Offices, through any one of 900 independent pipe distributors.

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Youngstown – growing force in steel

For complete information about Youngstown line pipe, write Dept. 18-B,
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Plant-Owned System or Private Hauler Service Cuts Your Costs... Eliminates Unsightly Trash Piles

If trash piles, battered cans, scattered refuse, fire hazards and hit-or-miss collection are present in your plant, it may pay you to investigate the DEMPSTER-DUMPMASTER System.

You can own your own system or secure this vital service without capital outlay from one of the many Dumpmaster-equipped private haulers who operate in most major cities.

Clean, big-capacity containers, spotted at refuse accumulation points throughout your plant, provide enclosed, out-of-sight storage for waste and refuse, increasing plant cleanliness and improving employe morale.

Write today for a free brochure that describes this system and the name of your nearest private hauler.

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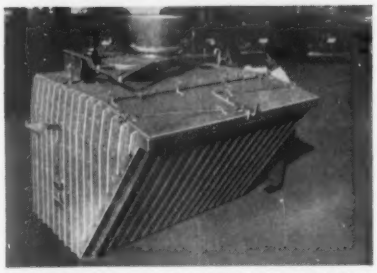
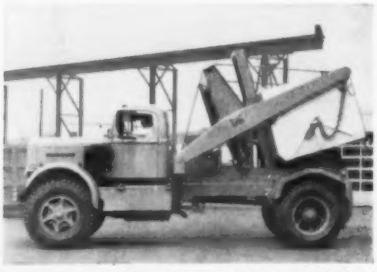
Dept. PE-9 KNOXVILLE 17, TENNESSEE

NEW PRODUCTS



CONTAINER FOR HOT MATERIALS

This 6 cu. yd. tilt-type container was specially built to store and handle a high-temperature dusty product. It has cooling fins, a counter-balanced spring-hinged lid and a 16" sliding gate valve. When full it is picked up, hauled and emptied by a Dempster-Dumpster. Details are contained in a free brochure entitled "Special Containers." Dempster Brothers, Inc., Knoxville 17, Tenn.



NEW LFW HANDLES CONTAINERS

This new LFW 603-C, mounted on a White Mustang, was produced to handle scrap metal storage containers. It will handle containers in capacities up to 15 cu. yds. in all Dempster-Dumpster models. Lifting capacity is 18,000 lbs. Dempster Brothers, Inc., Knoxville, Tenn., offers a catalog brief No. 160 describing this and other materials handling systems.

PORTABLE FUEL OIL TANKS

This 2,000-gallon tank was produced for operation at temperatures as low as −90° F. It features its own pump and gasoline engine. Prime mover is a truck-mounted Dempster-Dinosaur which hydraulically lifts the tank into carrying position and puts it off. A new catalog section No. 12 describes the development. Dempster Brothers, Inc., Knoxville 17, Tenn.

Advertisement

Now! The LUNKENHEIMER BALL VALVE

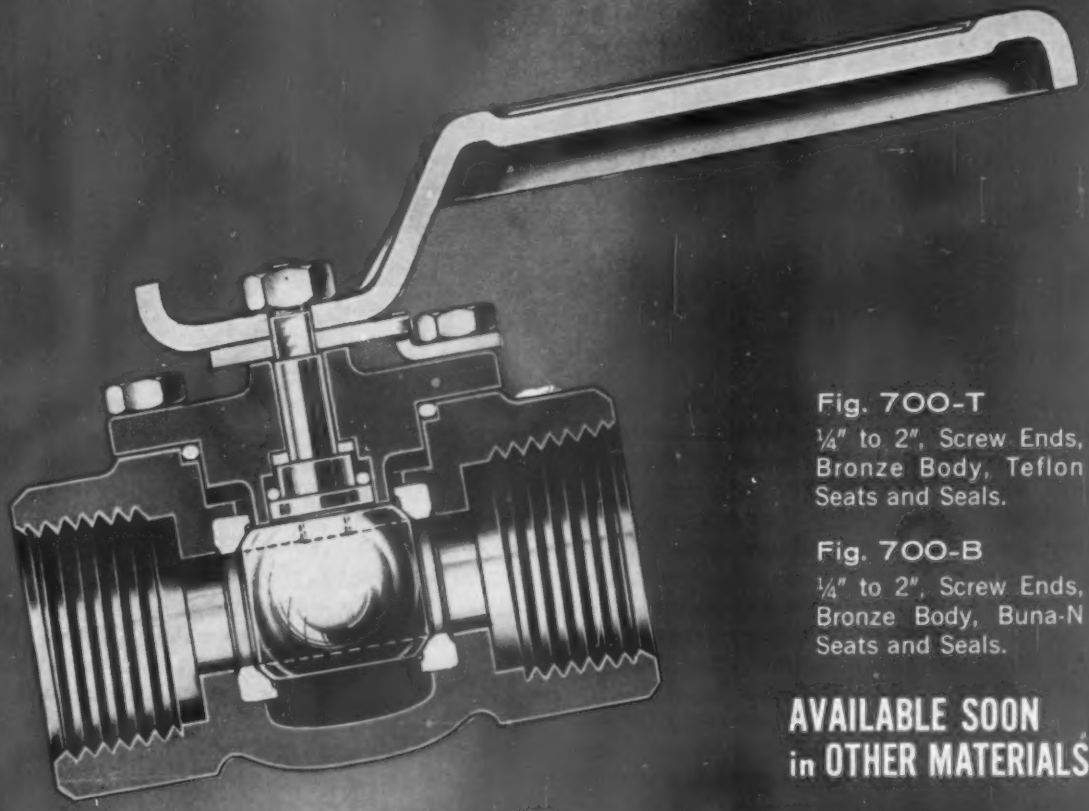
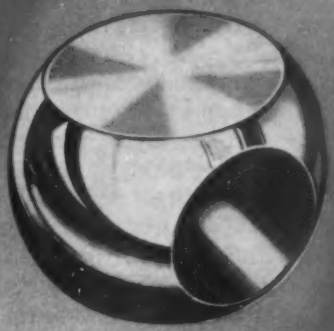


Fig. 700-T
¼" to 2", Screw Ends, Bronze Body, Teflon Seats and Seals.

Fig. 700-B
¼" to 2", Screw Ends, Bronze Body, Buna-N Seats and Seals.

AVAILABLE SOON in OTHER MATERIALS

New Top-Entry Design



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An interview with A. P. Blair

Nationals Get Job Advantages

by Ernestine Adams

Underdeveloped countries benefit from efforts of foreign companies to develop personnel, says A. P. Blair, until recently head of personnel development for Shell International Petroleum Company. The Royal Dutch/Shell Group operates in more different countries and territories than any other one private organization in the world. Mr. Blair has unique experience in finding and developing management.

He joined the Group in 1925 after finishing at Winchester and Cambridge. He served in India on the marketing staff of Asiatic Petroleum, returned to London in 1937 and during the war was seconded to the British Ministry of Information and to the Admiralty.

After a number of years as head of Shell's recruitment division in the United Kingdom Mr. Blair spent two years visiting 45 countries in Asia, Africa, South America and parts of Europe where Shell had companies. His task was to formulate and coordinate for each country those long-term programs of staff integration and management development that are today one of the Group's valuable assets.

This interview was held in London just previous to Mr. Blair's retirement after 35 years with the Shell Group.

Q. Mr. Blair, I suppose there are not many countries in the Free World where you couldn't find a Shell employee — or on any of the high seas, for that matter. How many employees does the Royal Dutch/Shell Group have?

A. Some quarter of a million men and women drawn from all races and environments.

Q. And from these you develop managers for the future. I'm primarily interested in your efforts to bring nationals into management. Your basic policy is international, is it not?

A. It must be because, as you know, the Royal Dutch/Shell Group is not only one of the largest but the most international private enterprise in existence and today it relies upon employees educated in almost every country of the Free World. The Group is composed of scores of local companies and each one is responsible for the training and development of its management within the larger policy of the international program. For that program we first draw the staff from as many nations as possible and then rotate them as much as possible to other nations to give them a feeling for the international character of our company.

Q. When did you begin this program of developing nationals for management?

A. We have been an international organization from the beginning and that is more than fifty years ago. When we started it was common practice for firms operating in foreign countries to be managed entirely by expatriates. Before World War I we hired and trained nationals to take on clerical and senior clerical work. Between the World Wars we developed a philosophy of management that turned from former practices. We decided that in each country in which we operated we should try to find nationals capable of training and promotion into the top management team of the local

company. We went even farther — we determined that no consideration of race or origin should of itself stand in the way of any employee rising to the highest position.

With this new approach in mind, we knew it was no good to wait for candidates. We went out and searched for nationals with potential executive qualifications. Where the local system was not producing them we took a long term view and helped set up educational branches to provide candidates with required qualifications.

Q. When you first began to put this philosophy into practice how did it come out?

A. Well, frankly, in many countries this was pretty radical, and the wastage was inevitably high. The background and pattern of thought of the nationals in training differed widely from the expatriates who were in charge. It was certainly a slow and often costly process of trial and error. We had to discover the methods appropriate to a given country for developing its nationals into successful executives in a western-type organization.

Q. Did the program change after the war?

A. Before, we weren't being pressed to do what we intended to do anyway nor to go faster than we thought might be wise. When the war was over, national sentiment sought to complete a change overnight. We had to press on as quickly as possible toward associating the nationals of the emergent countries with the conduct of our business if our Group was to stand a chance of remaining an acceptable part of their economies. Inevitably this meant taking a risk of "forcing" the individual career development of some nationals.

Q. You can probably find plenty of nationals who want to work for you, but isn't it very difficult to find people whom you can train for management or technical positions?

A. Of course, you run into a number of problems. You can usually attract applicants but it's hard to get the kind of people you want. In some places, like Ceylon or Thailand, in the past it was not the tradition for well born or well educated people to go into business. It was considered below them. We had to convince men of this class that we had something to offer.

Also there were few cases to point to where a national already held a position of top responsibility in a foreign firm. Qualified young men seldom considered a career with an international oil company. They went into the traditional professions of lawyer or politician. Although initial progress was slow, we learned not only to attract these candidates but to develop methods that held their interest and made them willing to work to become responsible and effective members of the company. In early days we'd lose up to 60%, but by persistent experiment we learned to do better.

Q. Was one of the problems remuneration?

A. In some countries it was difficult to fix a starting salary because customary pay of

senior local clerks was so much below that of the junior expatriate. I remember a case some 12 years ago in a small Asian country when we began to look for trainee executives. Local clerks started on less than £200 a year compared to the £600 or £700 of the junior expatriate. We offered £400 for the local junior executive cadet, believing that we could not attract the type of man we wanted for less. This caused quite a sensation at the time, but quickly became accepted practice.

The expatriate needs more to live in any country than the local, of course, so our policy is to fix a single salary bracket for any job in a given country and then to pay the expatriate a supplement determined by his extra training costs. The same rule applies, of course, if the national is brought to England.

Q. What about promotion through the ranks from within the local company? Does that work for nationals?

A. Yes, we always try to grow our own timber, nationally and internationally, at all levels. It is, however, of special advantage to morale if in the early days of local cadet recruitment it is found possible to promote one or two of the more competent and long-service clerks into the executive ranks. Their salary and prestige are increased and, provided they are recognized by their colleagues as good men worthy of such promotion, the way to the top is shown to be open for men of ambition and ability whatever their origin; not just reserved for the cadet with a silver spoon in his mouth.

Q. Well, after you've recruited your potential manager, I suppose all you have to do is to train him for the job.

A. You have to do another thing first. You have to find out how to train the young local executive. The right way will not always be the same as it is for an expatriate nor for the nationals of another country.

Q. I'm sure you have a variety of means of training — what are the basic methods?

A. I'd name four methods:

1 — Job rotation at home.
2 — Formal training.
3 — Job in Central Offices.
4 — Job with another Shell operating company.

In the job rotation in the man's own country, we feel the most important item is to put him under a sympathetic supervisor who knows what you're trying to do and is prepared to back it even to taking risks in the responsibilities he is prepared to delegate to the trainee.

Q. You mean it's more difficult to delegate in some Asia-African countries than in Europe?

A. You can't train a man in the Far East, for instance, as you would a European. A European will stick his neck out. You can give him a job and he'll do it on his own; be ready to make mistakes and learn from them.

But you're not going to get far training a recruit in that way in certain Asian countries. In Japan it is by tradition impolite to ask your teacher a question since it implies that he has not covered the subject adequately. If you do make a mistake, loss of face is worse than if you had done nothing in the first place. So we must weave a different training pattern to fit these circumstances. First a trainee is taken inch by inch over a given piece of ground until he knows all of it by heart. After that he is encouraged to carry out the work on his own. When he is thoroughly accustomed to doing a particular job then he must be prepared to go through the next job, in the same step-by-step method. Another thing, his field of responsibility must be explicitly defined and written down so he cannot shelter behind a plea of ignorance of which decisions to make himself, which delegate and which refer to his superiors.

Q. You've told some difficulties in recruiting reluctant candidates. What about volumes?

A. We had a good example of that in Nigeria. In 1959 we wanted 50 candidates for our trades school at Port Harcourt, where a 3-year course is designed to turn out skilled workmen and potential supervisors. We had 5,000 applications, interviewed and tested 500. In those selections we had to create and apply methods of interviewing and testing different from those used in our own country.

They had to be set up to fit Nigerians. Of the candidates, 43 were accepted and after 6 months training all except 8 passed the exams. We call this high survival. When we announced openings in 1960 some 20,000 applied, 600 interviewed, 500 took tests and 60 accepted.

Q. So you must develop both new methods of selection and new ways to train?

A. We've certainly learned we can't apply our type of selection and training to nationals of developing countries who do not share our tradition and background. We can work together only if both sides make adjustments of an imaginative and sometime courageous order.

Q. What are these new nationals like? Are they smart?

A. They are intelligent, yes, and they are in a hurry. The postwar nationals of developing countries are giving themselves less time to prepare for responsibility than we are accustomed to. The first generation of cabinet ministers of some of the newly independent countries in Asia and Africa often average as low as 35 years. These young men are running the country — often on a briefer apprenticeship than we would think necessary to turn a university graduate into a junior executive. They regard business as being no more complicated than government and expect international enterprise to take nationals, train them, and promote them overnight into partnership in local business management.

Q. I can see that could be disrupting. You can't telescope training very well. What comes after on-the-job rotation in the local company?

A. A local staff member, after a successful period in his own country, is usually brought to the Central Offices in London or The Hague for periods of responsible work and for a residential course with nationals of other countries.

Bringing such men for longish periods to work in the entirely different environment of Europe can — if the men are not very carefully selected and understandingly handled — be full of chances. I remember once, a good many years ago, we brought over three nationals chosen simply on senority from a certain country for a professional refresher course. One got as far as New York and returned home on receiving a cable that his wife was starting a baby and she could not carry on without him. The second, after a few months in England, returned home because his wife was not starting a baby and she demanded that he come home and do something about it. The third stayed and completed the course with such success that on his return he thought he was too good to fill the job we had for him and left us.

Q. So you bring in nationals to England or possibly to Holland for special courses or to work in the Central Offices. Do they often do both — take a course at one time and later hold a job in the Central Offices?

A. Yes, that's possible. Then for some men there is a fourth step in this training. This is a period of working in another operating company, an extension of the rotation system that we use locally. Usually a staff member is sent

to another company that is further along the road and has a different view of problems.

For instance, one may be sent from Lebanon to Ceylon for two years to fill a job similar to his own but drawing upon differing experiences and exchanging ideas. We have now at any one time about 60 nationals in other countries where they will work from six months to two years. This develops an international pool of management material for the future. Where successful the pay-off is high but unless handled with imagination it can be even more hazardous than bringing the local staff member into the Central Offices.

Q. How successful do you think your program has been?

A. Royal Dutch/Shell's expatriates serving overseas number around five thousand. Now this total has been almost unchanged in the past ten years, although the volume of our business has doubled, so you can see that the extra staff has been made up by local recruitment and promotion.

In the future we expect the number of career expatriates to fall, although it is not our intention to replace them wholly by local staff. We believe the ideal in an international business to be: At all levels and in all functions an admixture of men from other countries should work side by side with the local staff and bring outside experience to bear on local problems.

Q. Can you give me an example of the proportionate number of locals to expatriates?

A. It's hard to tell at one moment exactly the number of locals in our management, but one country will give a good example. In 1949 in Ceylon our 18 staff members above the clerical level were all expatriates. Our business had expanded considerably by 1956 and then the

senior staff consisted of 22 Ceylonese and 17 expatriates.

In 20 countries in Asia, Africa and South America of every 10 senior jobs 6 were held by expatriates in 1950, 4 in 1959 and by 1963 it will be 3. By the '70's I think our management teams in many of these countries will be largely local and the senior staff almost wholly so, except perhaps for exchanges of nationals and training expatriates. Advisers and consultants from Central Offices will supply specialist and international know-how to local management.

Q. Will organization need to be changed to handle this change in your personnel?

A. We see some ways in which there will have to be changes. For instance, not long ago in one African territory we appointed our first African as district manager, a post always held by an expatriate. He had only been six years in the company and although a very capable man, we could hardly have done this but for the fact that the district was small, homogeneous, and accessible. In another African territory, where each district was much larger, and more diversified, we found that the districts would have to be broken down, at best temporarily, into less complex units if we were not to wait a number of years before our first African would be sufficiently experienced to take over.

Q. What other problems do you foresee?

A. One is there was little need to differentiate in functional departments when we had European engineers who generally were all-around men who could turn their hand to most aspects of operational and maintenance engineering. In some countries, however, the locally trained engineer is more highly specialized and has an inclination to stay within his particular type of work. This may mean more rigid functional planning with more closely defined responsibility. It doesn't leave a great deal of leeway for moving staff from one job classification to another. This brings a trend to the one-man job, for which a successor is trained beginning several years before the employee is retired.

Q. How far ahead do you plan your management fulfillment?

A. Right now we have tentative succession planning for top management jobs up to 1970. In the training of top managers we try to look 15 years ahead. In planning recruitment we try to analyze what our needs may be in 1980.

Q. How do you determine requirements?

A. We use past performance and events, of course. We review the happenings and trends of 1950-60, what the needs were then, the kind of people that made up our employees, the kind of careers we had to offer them and the success ratio of our recruitment.

Also from every operating company comes an estimate of its own future establishment and the proportion of nationals to expatriates needed. The local director must have a program for the men coming along and long term plans for their place in the company. It is on the basis of these returns that the Central Offices plan their recruitment of the international or expatriate staff for which overseas managers will call to supplement their local resources.

Q. Is this responsibility left entirely to the local manager?

A. Within his own area it is his responsibility but the Central Offices collect and collate individual reports on the expatriate and most senior nationals and a committee reviews each employee's performance each year. The reports are appraised both for the individual's potential and for what he needs to realize it.

A local manager may say, "This man can handle such and such job here but he needs first a period of study elsewhere to improve his technical background." Or the Central Offices may say "There is a bigger opportunity for So-and-So in country 'X' than he will ever get where he now is. Let's ask his local manager whether he is prepared to release him."

A mechanized record, brought up to date each month, is maintained in the Central Offices of all international and potentially international staff. If there were a call for a man with blue eyes who spoke Portuguese, we could turn him up.

Q. Do you think Shell's policy of recruiting and training nationals has paid off?

A. In time I believe we'd have had no choice, but I'm pleased to think the Group of its own volition tackled the problem early. Our future depends upon the quality of our staff and the prosperity of our customers. As part of our world-wide responsibility we must assist nationals to share in management.

We must, as part of our "staff integration," train and develop each individual to the fullest extent of his abilities irrespective of race or background. To the extent that we succeed in doing this there is no question at all but that it pays off both for ourselves and for the national interest of the countries in which we operate.

■

Special report to users of Caterpillar equipment:

CAT CATERPILLAR

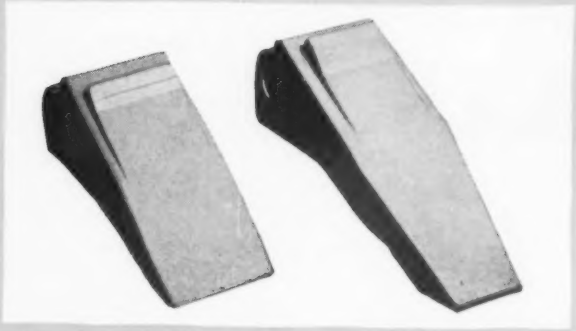
Parts you can trust
...cost less per hour

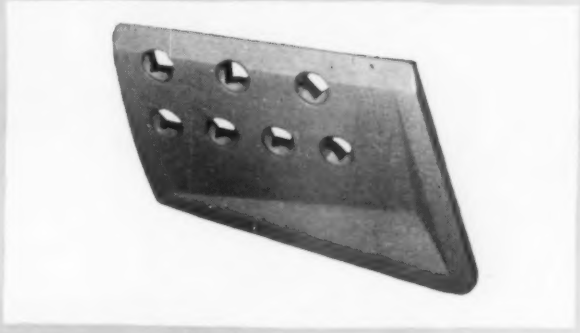
New Cat No. 8 and No. 9 Ripper Tips outproduce other brands 25 to 50% in field tests

That's the kind of news you can use—to cut costs. This newcomer to the Caterpillar line of ground-engaging tools is making a name for itself with cost-conscious users.

They're exceptionally wear-resistant—hardened to Rockwell C50 for longer wear-life under any conditions.

Check the price! Improved Cat Tips sell for about the same *or even less* than other leading brands.





They're available in two new designs. Both the short and long tips shown in the photograph are *self-sharpening* to keep their working edge until replacement. The long tip gives extra wear-life with only a slight reduction in impact strength. Low-cost, weld-on shank adapters are available for *all brands* of shanks. No need to wait—you can put these new Cat Tips on your job immediately.

In field tests the short tip was pitted against two leading brands on rippers working in caliche and cemented conglomerate beds. The Cat Tip outproduced the other brands 25-50%—representing savings of 38-54% in replacement costs.

Outstanding impact strength! One No. 9 Tip, tested in *solid* granite, took 13 smashing blows from another D9 pusher that backed up 10 feet before each charge at the stalled D9 Ripper.

And here's another money-saving newcomer—Cat's new No. 7, No. 8, No. 9 End Bits are redesigned for better digging ability. They self-sharpen as they wear away for continuing like-new performance. They're forged alloy steel and heat treated for outstanding strength and wear-resistance.

Compare other ground-engaging tool brands against the Caterpillar line. Keep machine-hour records and find out for yourself which is the best buy. Those who do, buy Caterpillar.

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Profit Margin Widens

Gains slowed to a brisk walk in the second quarter after a sprint in the first. The 10% increase in earnings on a 3.6% rise in revenues in the second quarter of 1961 over 1960 is still a remarkable performance.

Profits for the first half rose 13.3% with gross income moving up only 3.5%.

These figures are based on reports of 64 companies to their stockholders. A variety of causes were given for profit improvement or lag.

Tex-Star, a young company, said its oil and gas sales more than doubled. Cities Service referred to larger production and sales volumes. Union of California said sales of natural gas, natural gas liquids and crude oil were up. Sun named oil and natural gas liquids production (up 6%). Standard Indiana said its output of the two was up 11%, primarily in Argentina and Canada. Standard California added that its natural gas sales had gained 22% over first half of last year. Gulf reported its increases continued to come from U. S. operations, including more production.

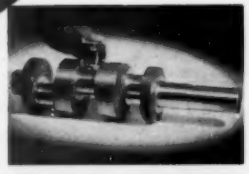
Murphy credited marketing volume and better integration of facilities for higher earnings. Cosden pointed to significant growth of petrochemicals, up 25% in its fiscal year. Jersey Standard reported 6-month increase was due to improved price structure in the U. S. and volume gains abroad but warned price weakness and intensive competition would slow down gains.

Sunray Mid-Continent also expressed concern over refined products price during last half. Texaco reported earnings adversely affected by 18-day maritime strike.

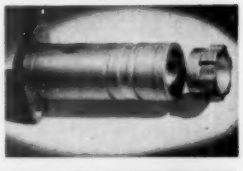
Most important to the industry is the slightly better profit margin on sales. In 1961 company earnings were 8.6% of revenues compared with 7.8% in the first half last year. This is the figure that proves the oft-repeated words "operating efficiencies."

NEW! FRANK WHEATLEY'S P-200

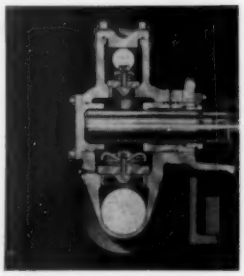
FRANK WHEATLEY'S P-200 is the product of customer demand for a P-175 "PLUS" . . . a greater volume pump with the same features as the economical P-175. The challenge was met and the result is a plunger pump with 20% more volume, perfect for packaged flood units due to its lightness and compactness. The 16 H.P. P-200 triplex, with 1⅛" — 1¾" x 2⅛" plungers, delivers volumes to 1,150 BPD with pressures to 1,760 PSI. All this — at no increase in cost.



The P-200 is equipped with Frank Wheatley's EXCLUSIVE Offset Crankshaft Design. This widely acclaimed feature results in a stronger, more compact pump.



The P-200 features still another Frank Wheatley EXCLUSIVE: Unitary Cylinder Heads and Stuffing Boxes for quick and easy maintenance in the field.



Large Suction, small discharge valves is another Frank Wheatley "FIRST". This EXCLUSIVE DESIGN FEATURE means more positive filling and faster valve action.

FRANK WHEATLEY

WRITE: FRANK WHEATLEY PUMP & VALVE MFR. / P. O. BOX 1948 / TULSA, OKLA.

FINANCIAL REPORTS OF 63 PETROLEUM COMPANIES

Company	Second Quarter[1] Gross ($1000) 1961	1960	% Change	Net ($1000) 1961	1960	% Change	Six Months[1] Gross ($1000) 1961	1960	% Change	Net ($1000) 1961	1960	% Change
Ambassador	1,488	1,619	— 8.1	222	181	+ 22.7	2,915	3,278	— 11.1	395	694	— 43.1
American Petrofina							38,249	35,531	+ 7.6	820	(385)	
Amerada Pet.	23,520	24,516	— 4.1	6,345	6,417	— 0.1	50,722	51,829	— 2.2	14,141	13,723	+ 3.0
Apco	14,859	15,095	— 1.6	746	387	+ 92.8	29,498	28,631	+ 3.0	1,743	902	+ 93.2
Argo Oil	3,718	3,648	+ 1.9	1,438	1,439	— 0.1	7,800	7,292	+ 7.0	2,860	2,443	+ 17.1
Ashland O & R	76,103	71,708	+ 6.1	3,236	2,894	+ 11.8	149,959	149,775	+ 0.1	6,806	6,302	+ 8.0
Atlantic Ref.	134,254	125,614	+ 6.9	6,779	8,191	— 17.2	290,724	279,215	+ 4.1	21,649	16,917	+ 28.0
Aztec Oil & G.	2,428	1,930	+ 25.8	1,369	1,027	+ 33.3	4,680	4,167	+ 12.3	2,649	2,444	+ 8.4
Champlin O & R.	22,320	20,715	+ 7.7	2,332	1,488	+ 56.7	44,195	41,090	+ 7.6	5,341	3,362	+ 58.9
Cities Service	234,334	227,938	+ 2.8	9,167	5,698	+ 60.9	501,059	493,729	+ 1.5	23,919	18,672	+ 28.1
Clark O & R.	20,416	19,553	+ 4.4	(244)	193		43,284	42,094	2.8	17	208	— 181.7
Colorado O & G.	11,888	11,593	+ 2.5	1,015	(134)		23,825	22,587	+ 5.5	2,152	(313)	
Commonwealth	20,979	20,493	+ 2.4	2,828	1,385	+ 104.2	44,021	33,920	+ 30.0	6,103	1,048	+ 482.3
Continental Oil	210,613	205,546	+ 2.5	12,887	13,430	— 4.1	420,683	414,953	+ 1.4	28,722	28,983	— 0.9
Cosden Pet.[2]	19,703	19,579	+ 0.6	1,085	736	+ 47.4	82,132	82,497	— 0.5	4,770	4,763	+ 0.1
Delhi-Taylor	26,900	21,400	+ 25.7	650[3]	725	— 10.4	57,900	47,300	+ 22.4	2,750[3]	2,150	+ 27.9
Eason Oil	1,023	855	+ 19.6	173	52	+ 232.7	1,989	1,889	+ 5.3	365	226	+ 61.5
General American[4]	8,052	7,528	+ 7.0	628	(32)		23,810	20,402	+ 16.7	3,836	2,163	+ 77.3
General Crude							6,331	6,190	+ 2.3	1,421	1,237	+ 14.9
Getty Oil	19,363	17,623	+ 9.9	3,693	1,506	+ 145.2	36,707	31,721	+ 15.7	6,810	4,429	+ 53.8
Gulf Oil				74,386	74,272	+ 0.2	1,632,005	1,604,333	+ 1.7	169,701	156,096	+ 8.7
Helmerich & Payne[5]	3,687	2,993	+ 23.2	457	23	+ 1887.0	8,893	7 250	+ 22.7	1,117	359	+ 211.1
Hugoton Prod. Co.	1,311	1,024	+ 28.0	562	438	+ 28.3	3,586	3,785	— 5.6	1,681	1,846	— 8.9
Kern Co. Ld.	26,379	24,045	+ 9.7	4,255	3,737	+ 13.9	47,520	45,807	+ 3.8	8,312	7,272	+ 14.3
Leonard Ref.	13,652	12,730	+ 7.2	131	350	— 62.6	27,235	26,783	+ 1.7	397	768	— 48.3
Louisiana Ld. & Exp.	11,934	10,862	+ 9.9	6,016	5,458	+ 10.2	24,137	22,150	+ 9.0	11,874	11,062	+ 7.3
Maracaibo Oil	385	438	— 12.1	47	61	— 23.0	775	842	+ 8.0	98	118	— 17.0
McCulloch Oil							1,018	915	+ 11.3	190	124	+ 53.2
Midwest Oil	5,988	4,882	+ 22.7	2,138	1,581	+ 35.2	11,618	10,068	+ 15.4	4,129	3,399	+ 21.5
Murphy Corp.	23,262	21,481	+ 8.3	1,033	750	+ 37.7	46,812	43,396	+ 7.8	2,340	1,898	+ 23.2
Ohio Oil	87,675	83,919	+ 4.5	8,807	7,454	+ 18.2	178,896	175,973	+ 1.7	19,300	17,733	+ 8.8
Olin O & G.	11,607	11,218	+ 3.5	909	463	+ 96.3	23,808	23,621	+ 0.8	1,865	1,625	+ 14.8
Phillips Pet.	303,162	301,672	+ 0.5	27,396	25,944	+ 5.6	607,290	603,099	+ 0.7	54,902	51,748	+ 6.1
Plymouth Oil				(504)	(239)					623	43	+ 1348.8
Producing Prop[7]	2,808	2,342	+ 19.9	163	266	— 38.7	5,734	4,521	+ 26.8	565	825	— 31.5
Pubco Pet.	954	514	+ 85.6	373	78	+ 378.2	1,851	1,165	+ 58.9	761	271	+ 180.8
Pure Oil	167,736	160,513	+ 4.5	4,046	7,054	— 42.6	336,592	328,452	+ 2.5	10,874	13,756	— 21.0
Quaker State	13,314	13,655	— 2.5	497	364	+ 36.5	27,211	26,386	+ 3.1	748	765	— 2.2
Richfield Oil	63,739	69,332	— 8.1	3,757	6,993	— 46.3	137,460	138,091	— 0.5	9,179	13,988	— 34.4
Shamrock O & G.	15,672	16,487	— 0.5	2,135	2,437	— 12.4	30,443	32,294	— 5.7	4,811	5,018	— 4.1
Shell Oil	465,243	443,944	+ 4.8	34,974	34,767	+ 0.6	929,783	898,199	+ 3.5	69,683	69,312	+ 0.5
Signal O & G.	81,358	76,918	+ 5.8	1,840	4,235	— 56.6	162,992	151,880	+ 7.3	5,927	7,604	— 22.1
Sinclair Oil	286,175	288,657	— 0.9	7,066	9,015	— 21.6	616,939	622,960	— 1.0	23,162	21,662	+ 6.9
Skelly Oil	61,217	59,897	+ 2.2	5,319	5,181	+ 2.7	125,125	125,236	— 0.1	11,813	11,090	+ 6.5
Socony Mobil				49,000	36,200	+ 35.4				108,800	83,400	+ 30.4
South Penn.	—	—	—	—	—	—	29,724	29,818	— 0.3	1,812	1,898	— 4.5
Standard Calif.	530,344	501,112	+ 5.8	70,509	67,861	+ 3.9	1,024,719	980,710	+ 4.5	136,482	128,589	+ 6.1
Standard Ind.	495,647	485,464	+ 2.1	30,357	33,196	— 8.6	1,026,600	1,000,316	+ 2.6	74,177	64,887	+ 14.0
Standard N.J.	2,202,000	2,096,000	+ 5.1	192,000	145,000	+ 32.4	4,488,000	4,299,000	+ 4.4	385,000	315,000	+ 22.2
Standard Ohio	105,954	96,406	+ 9.9	6,131	5,890	+ 4.1	186,422	182,012	+ 2.4	11,649	10,956	+ 6.3
Sun Oil	205,222	183,994	+ 11.5	12,037	11,242	+ 7.1	401,026	366,800	+ 9.3	24,048	20,032	+ 20.0
Sunray Mid-Cont.	119,950	115,983	+ 3.4	10,909	9,303	+ 17.3	238,536	228,432	+ 4.4	21,916	18,743	+ 16.9
Superior Oil[8]	36,133	33,298	+ 8.5	4,232	6,056	— 30.1	111,245	95,146	+ 16.9	17,160	18,550	— 7.5
Texaco Inc.	791,719	795,723	— 0.5	90,585	80,029	+ 13.2	1,595,186	1,529,591	+ 4.3	198,726	177,342	+ 12.1
Texas Gulf Prod.	4,346	4,008	+ 8.4	1,283	1,201	+ 6.8	8,461	8,176	+ 3.5	2,425	2,414	+ 0.5
Texas Pacific	6,672	6,515	+ 2.4	1,724	1,864	— 7.5	13,524	13,246	+ 2.1	3,523	3,968	— 11.2
Tex-Star O & G[3]	1,228	908	+ 35.2	598	416	+ 43.8	1,228	908	+ 4.8	598	416	+ 43.8
Tidewater Oil	143,539	144,029	— 0.4	3,739	12,345	— 207.1	298,924	287,729	+ 3.9	14,718	18,277	— 19.5
TXL Oil Corp.	3,400	3,216	+ 5.7	498	568	— 12.3	6,574	6,510	+ 1.0	1,320	1,390	— 5.0
Union Oil Calif.	138,537	137,462	+ 0.8	7,607	7,840	— 3.0	267,095	260,671	+ 2.5	16,771	13,370	+ 25.4
Union Tex. Nat'l.[9]	21,053	19,000	+ 10.8	2,761	2,734	+ 0.1	46,640	40,133	+ 16.2	6,957	6,206	+ 12.1
Universal Cons.				923	551	+ 67.5				1,997	1,227	+ 62.8
Wilcox Oil	1,361	1,423	— 4.4	173	200	— 13.5	2,946	2,830	+ 4.1	383	446	— 14.1
TOTAL	7,305,374	7,048,517	+ 3.6	725,218	658,261	+ 10.2	18,454,379	17,837,307	+ 3.5	1,581,783	1,395,635	+ 13.3

[1] Quarter and first half ending June 31 or closest to that date available.
[2]. Fiscal year ending April 30.
[3]. Reflects Three States assets only for month of June.
[4]. 9 months ending March 31.
[5]. 9 months ending May 31.
[6]. 6 months and quarter ending March 31.
[7]. 6 months ending February 28.
[8]. Adjusted & restated to reflect rate case settlement.

How to Conduct Conferences

by Kent Williams

The conference has become so much a part of the American way of life that we have developed a tendency to take it for granted. It seems that most of our pursuits, both on and off the job, are either affected by or accomplished through some form of conference activity. Our governmental decisions are made by conference. Conference decisions rule our business policies and transactions, both within and between companies. Even the administration of our group social and recreational activities is discussed in conference.

As a manager or potential manager one of the most useful skills which you can develop, is ability to effectively lead a conference.

Cushman defines the conference as "a systematic, though somewhat informal, thinking through of problems by a group of experienced persons."[1]

We'd like to add, "under a qualified leader." A leaderless conference is destined to drift around in random fashion until sunk or run aground. The leader must be the captain of his conference —there must be no misunderstanding about who is running the show.

The experience of the group members is of great importance to the applicability and success of the conference method, because for maximum effectiveness, active participation is required of all group members. In fact, Cushman goes so far as to say that "persons who have had no experience related to a given problem cannot participate in a conference on that problem."[1]

It is usually desirable, although not always possible, to obtain conferees who are at about the same level status-wise. This will obviously make for a freer interchange of ideas.

By way of summary, then, we see that the conference, as here defined, must have the following essential ingredients:

1. A problem or decision which needs to be resolved.
2. A group of experienced people, willing to think and talk freely about the problem.
3. A qualified leader.

As individuals who are interested in developing management skills, we are mainly concerned with the third ingredient — conference leadership.

Many conferences are poorly conducted. This is probably due in part to the large number of conferences taking place every day. It is also due to a lack of understanding of methods. The primary blame for poor conferences, however, is ineffectual leadership, since everything that happens in any conference is actually the responsibility of the leader.

First requirement for a successful conference is careful advance planning. If you are going

[1] Frank Cushman, "Foremanship and Supervision," John Wiley.

"The more valuable the tool, the more skill that is required in its proper use, and, correlatively, the greater the possibilities of abuse."—Carl Heyel

to conduct a conference, you should prepare in advance some sort of written plan, to be kept in front of you throughout the meeting. This need not be a comprehensive formal outline, but should consist of a listing of the main points to be covered, with possibly a rough estimate of how much time should be spent on each. The leader has an obligation at this point to assist the individuals who will be attending the meeting with their own self-preparation. Charles E. Spahr, president of the Standard Oil Company of Ohio, highlighted this important consideration in a recent address: "The committee meeting should always be preceded by a written agenda. The agenda and any reading material should be sent out well in advance of the meeting, and there should be an understanding that committee members must do their homework before they come to the meeting."

Upon opening the conference, you should plan to make a brief introductory statement (2-5 minutes) in which you outline the problem and set the stage for the discussion. Brevity of your introduction is significant to the probability of success for the meeting. Cooper says: "During these moments the group is functioning as an audience. Its members are passively listening to you. This is exactly the opposite of the conference situation, in which everyone is expected to take part in the meeting. And the longer you talk at the opening of a conference, the more deeply will the group sink into a state of passivity."[2]

It is a good idea, at the close of your introductory remarks, to pose the problem in the form of a question. Having thrown out the question to the group, you should keep quiet until someone breaks the ice by speaking.

I once attended a conference where the leader proceeded admirably up to this point. He introduced the subject, wound up by stating the problem to the group in question form, and was then faced with a "deathly hush" while the group pondered. Evidently feeling that he had failed to state the problem clearly, the leader attempted nervously to rephrase it. This broke the trend of thought of the group members, and had the effect of weakening his position as the leader. Remember, the group cannot discuss the question until they have had a chance to think about it. If the question is not clear to them, they will ask you about it.

As the group begins to respond, you should acknowledge each person's contribution, making sure (by restating, if necessary) that each individual's statements and opinions are clearly placed before the group. At this point it is very important that you gain the confidence of the group members and establish a working relationship with them. As the leader you must be completely impartial and make no effort to express agreement or disagreement with comments made by the group.

Once you have succeeded in gaining the confidence of the group, your further progress depends upon your ability to incite and maintain discussion. Although you should have at least a rough outline it should be flexible and you should be willing to deviate from it if the group shows particular interest in a specific phase.

In one of my early experiences with conference leadership, I was conducting a discussion of a group of college students. I had carefully prepared in advance a rather detailed outline of the points I thought should be covered, allotting a certain number of minutes to devote to each topic. About midway through the discussion I became aware that it was becoming increasingly difficult to elicit comments from the group. I finally resorted in desperation to calling on specific individuals for opinions on specific questions. Putting people "on the spot" in such a fashion further increased the reluctance of the group to participate freely. Needless to say, the conference ended in almost total failure. I did not realize until afterward that my insistence on keeping the discussion moving had cut off people's comments before they had a chance to make them. They were then somewhat deflated and mildly irritated at me, and had "clammed up" almost completely. The most successful conference leaders have the ability to "play it by ear", i.e., to sense the mood and responsiveness of the group and react in the manner which will best exploit the

[2] Alfred M. Cooper, "How to Conduct Conferences," McGraw-Hill.

interest and enthusiasm brought forth by the discussion.

Follow-up questions are very important. As the conference leader, you should begin inserting such questions at appropriate times once the discussion has actively started. The purpose of follow-up questions is to promote deeper and more thoughtful investigation of points which are brought up in the conference.

You will probably find as the meeting progresses that the group will tend to divide into two or more factional segments. Far from being undesirable, this sort of occurrence is essential to a really good conference. One of your most important jobs will be to extract, clarify and accentuate areas of disagreement as well as agreement. For example, you might say, following a statement by a member, "Then you are not in agreement with Mr. Smith?"

When group members have exhausted their store of comments, extracted everything of value from the question under discussion and appear ready to arrive at a consensus, you should give a closing summary. You will have to exercise judgment in deciding the best time to enter into this phase of the conference.

Your summation should be brief, explicit, impartial and fair, outlining the major ideas advanced during the discussion. If the conference is of long duration (in excess of 40 or 50 minutes) it may also be desirable to summarize from time to time throughout the meeting. This technique helps to keep the discussion moving along and will also help to minimize continual rehashing of arguments that have already been made. Listing of points on a chart or blackboard as they are brought forth will make it easier for you to summarize and the group to understand the course of the discussion.

With the final summation completed, put the question to a vote for a decision. This is usually accomplished quickly and satisfactorily by a simple showing of hands.

As with most types of so-called management skills, there is no substitute for experience in acquiring the ability to do a good job of conference leadership. Do not be discouraged if your first two or three efforts fail to produce results equivalent to your fullest expectations.

Conference Leader's Checklist

The successful conference leader —

- ☐ Plans carefully for the meeting in advance.
- ☐ Does not devote too much time to introducing the topic.
- ☐ Maintains control of the group without appearing to dominate.
- ☐ Tactfully employs follow-up questions.
- ☐ Directs the discussion so that each member of the group participates.
- ☐ Establishes a good working relationship with the group.
- ☐ Keeps the discussion on the topic.
- ☐ Doesn't waste time "belaboring the obvious."
- ☐ Calls upon conferees to answer questions raised by the group.
- ☐ Makes a smooth transition from one phase of the conference to another.
- ☐ Uses the blackboard or other visual aids effectively.
- ☐ Rephrases and/or records ideas and statements of conferees quickly, accurately, and precisely.
- ☐ Shows good judgment as to the proper time for summarizing or crystallizing the discussion.
- ☐ Secures understanding of important terms.
- ☐ Holds the attention of the group.
- ☐ Maintains the tempo of the discussion.
- ☐ Exhibits zest and enthusiasm.
- ☐ Quickly grasps and develops pertinent points offered.
- ☐ Does not leave questions unanswered.
- ☐ Is not abrupt and tactless in handling individuals.
- ☐ Wisely distributes time among various phases of the topic.
- ☐ Integrates various comments to clarify areas of agreement and disagreement.
- ☐ Avoids cutting off the discussion while worthwhile contributions are being made.
- ☐ Appears confident and poised.
- ☐ Avoids displaying annoying mannerisms.

The Author

Kent Williams, a field engineer in the sales technical division of the marketing department for Standard Oil Company of Ohio, has a BS in chemical engineering from Carnegie Institute of Technology, an AB degree from Baldwin-Wallace College and in 1959 received an MS degree in Industrial Management from Purdue University. He has had some experience in Sohio's process and products development division and long range planning.

■

People in Petroleum

Number of people in petroleum industry is decreasing. This has been true for a number of years, but it did not show up in the list of companies we surveyed until 1960.

Although the total was down, in special cases companies showed an increase. Murphy Corporation reported its gain was "primarily in the addition of the employees of Spur Oil Company, which was merged into Murphy and those of an independent marketing company in Florida acquired in 1960."

At Texaco "the net increase is principally due to the inclusion of 3998 employees of subsidiaries operating in the United Kingdom and Ireland which were consolidated in 1960."

Ohio Oil added people, principally those with "a higher degree of training and skill." One reason was overseas growth. More than 100 employees were sent to Libya to help staff the growing Oasis Oil organization.

Fewer Employees

Less people results from cost reduction programs. More efficient operations meant: (1) No surplus personnel; (2) Present employees must be trained or retrained for better jobs; (3) Support of education for long-term provision of skilled people.

In reorganizing, companies made great effort to take care of their employees. Many offered special voluntary retirement programs. Tidewater states that its program was so attractive to 700 eligible employees between 60 and 65 years that over 55% took advantage of it. The company benefitted because through reorganization, automation and more effective use of manpower, 250 positions were eliminated.

Atlantic transferred qualified workers to other jobs where possible and assisted displaced workers in securing employment in other industries.

Speaking of its reorganization, Standard Indiana stated, "We sought to place our high-caliber personnel in the positions in which both they and the company might best profit from the exercise of their special abilities. Reductions were accomplished through normal attrition and through special retirements; in other cases, liberal severance benefits were provided."

Automation is one of the avenues to greater efficiency. Sun Oil reported, "Use of automatic equipment was extended as an additional step toward improving efficiency. These advances are proceeding without impairing Sun's longstanding reputation for furnishing job security and steady employment."

Employee training and development were a natural outcome of improved efficiencies in operations. Sunray Mid-Continent said, "Development was aimed at improving performance and acquiring a broader understanding of new job responsibilities."

Promote Self-Development

A plan for new managers was begun by Continental Oil. It explained, "A training program designed to promote self-development in first-line supervisors was instituted in 1960. The course included policy, organization, and philosophy of the company. The faculty was from Continental's managerial group."

Said Standard Ohio, "Training efforts to upgrade the job skills of employees at all levels in the organization have been intensified, thus offering opportunities for self-development to more employees. Policies have been revised to encourage employee advanced education off-the-job."

Development plan used by Phillips Petroleum reached down to lower management. It reported, "Much greater depth of participation in the management planning program was achieved by having supervisors at nearly all levels enter into setting goals for each unit, based on company objectives. This afforded broader use of the knowledge and experience of all supervisors; improved performance; and helped train men for greater responsibility."

After careful study, an enlarged program was set up by Sinclair which embodies every element of personnel administration and establishes an enlarged

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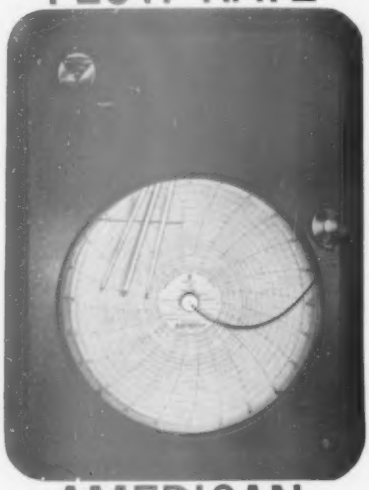

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PEOPLE IN PETROLEUM

Company	Holders of common stock		Employees, average		Payrolls & benefits ($1000)	
	1959	1960	1959	1960	1959	1960
Ambassador	3,163	3,337	168	160	1,358	1,454
American Petrofina	7,319	7,656	1,175	1,050	6,998	6,967
Anderson-Prichard	—	—	910	915	6,596	6,667
Argo Oil Corp.	—	—	185	177	1,831	1,834
Ashland O & R	41,944	42,249	4,600	4,600	—	—
Atlantic Ref.	53,149	55,025	15,394	13,967	112,680[1]	105,863[1]
Aztec Oil & Gas	9,214	9,509	47	50	325[1]	407[1]
Bishop Oil	605	554	55	50	485	465
Champlin O & R	—	—	1,536	1,527	11,500	11,600
Cities Service	—	—	17,900	17,800	—	—
Clark O & Ref.	4,588	4,631	2,880	2,650	—	—
Coastal States	3,365	4,110	201	278	700	1,000
Colorado O & G	9,436	8,920	1,399	1,317	7,195	8,615
Continental Oil	37,550	40,329	11,333	11,669	80,399	83,720
Cosden Pet.	11,000	6,234	1,059	1,122	6,496	7,475
Delhi-Taylor	15,000	13,500	681	757	5,775	6,625
Drilling & Exp.	2,400	2,400	337	284	2,800	2,402
Eason Oil	502	510	125	125	587	574
Frontier Refining	1,850	1,937	616	813	3,312	4,115
General American	4,546	4,676	523	499	3,035	3,018
General Crude	1,156	1,178	210	205	1,589	1,612
Getty Oil	14,348	14,651	588	569	1,459	1,410
Gulf Oil	100,805	118,099	50,700[6]	47,400[6]	302,447	308,849
Helmerich & Payne	3,700	3,700	684	675	3,202	2,879
Honolulu Oil	5,505	5,809	683	713	6,222	6,611
Hugoton Production	4,850	4,880	75	75	—	—
Intex Oil	980	990	84	79	679	685
Kerr-McGee	5,800	6,100	3,411	4,557	18,399	24,533
Kewanee Oil Co.	715	A[5] 917 B[5] 977	436	443	4,423	4,402
Leonard Refineries	4,500	4,548	656	636	5,010	4,775
Louisiana Ld. & Exp.	9,678	9,825	115	119	1,053	1,169
Macmillan Pet.	1,468	1,700	248	236	1,751	1,657
Maracaibo Oil Exp.	2,200	2,000	50	45	—	—
Midwest Oil	7,128	6,789	135	135	—	—
Murphy Corp.	1,500	6,430	808[4]	2,555[4]	4,423	10,741
Ohio Oil	43,769	43,687	7,534	7,631	55,970	56,576
Olin Oil & Gas	3,759	3,780	324	334	2,590	2,705
Pauley Pet.	2,650	3,190	188	304	500	640
Phillips Pet.	135,523	133,373	24,575[4]	25,209[4]	190,558	199,674
Plymouth Oil	9,058	8,560	927	907	7,356	7,220
Producing Properties	4,625	4,752	176	202	1,316	1,423
Pubco Pet.	5,054	7,976	42	45	287	316
Pure Oil	47,711[4]	51,675[4]	10,740[4]	10,108[4]	74,939	73,383
Quaker State	6,392	6,398	1,448	1,458	7,954	8,353
Richfield Oil	12,204	12,648	6,374[4]	6,303[4]	46,808	46,682
Shamrock O & G	6,941[4]	6,897[4]	990[4]	982[4]	6,600	6,750
Shell Oil	19,730	20,018	38,217[4]	38,290[4]	341,567	346,262
Signal O & G	13,381	16,189	3,176[4]	4,022[4]	16,149[1]	23,576[1]
Sinclair Oil	119,802	125,046	23,557[4]	21,770[4]	168,332	165,776
Skelly Oil	6,167	6,493	4,787	4,727	32,262	32,592
Socony Mobil	224,000	234,000	40,900[2]	36,400[2]	354,200[2]	327,200[2]
Southland Royalty	1,740	1,709	48	46	503	520
South Penn	11,047	11,190	2,341	2,398	13,317	14,345
Standard Oil Calif.	159,707	169,646	38,388	37,677	300,578	303,625
Standard Oil Ind.	158,553	160,099	43,569[4]	41,706[4]	348,411	343,997
Standard Oil N. J.	582,000	665,000	146,000	140,000	969,000	938,000
Standard Oil Ohio	37,915	39,011	10,690	10,308	80,254	76,945
Sun Oil	27,375	28,392	17,292[3]	17,219[3]	128,149[3]	129,857[3]
Sunray Mid-Con.	110,590	111,742	5,894[4]	5,768[4]	41,688	41,075
Superior Oil	2,674	3,080	2,693[2]	2,493[2]	23,200[2]	22,200[2]
Texaco Inc.	143,344	145,425	53,510[4]	56,658[4]	341,514	357,018
Texas Gulf Prod.	9,100	9,070	234	238	1,940	1,995
Texas Nat'l Pet.	5,740	6,188	46	55	215[1]	275[1]
Texas Pacific	5,765	6,296	449[4]	435[4]	3,549	3,370
Three States	12,500	12,500	98	98	668	675
Tidewater Oil	23,589	23,559	9,361[4]	9,036[4]	78,488	78,734
TXL Oil	8,900	9,200	79	85	—	—
Union Oil Calif.	50,400	48,700	7,846	7,877	64,933	65,432
Union Texas Nat'l Gas	6,528	7,476	1,266	1,300	—	—
Universal Cons.	3,400	3,800	76	79	725	727
Wilcox Oil	2,000	1,968	115	105	764	731
TOTAL	2,393,597	2,542,903	623,957	610,525	4,308,013	4,300,764

1. Payroll only.
2. U. S. only.
3. Oil Division.
4. At year end.
5. Class A and B common shares.
6. Includes employees in non-consolidated subsidiaries, hence these figures are not comparable to amounts for payrolls and benefits.

program in the field of employee and community relations. "Consistent with the objection of modernizing every feature of employee relations, increased emphasis is being placed on achieving more effective internal communications, on management development and community affairs."

Education Aid

Almost every company appears to have some type of scholarship for children of employees. For instance, Quaker State Oil Refining began one in 1958, which awarded $1500 a year and up to $6000 for four years.

Richfield adopted a new program to coordinate its efforts and to analyze the need for financial assistance in the higher education system.

Gulf Oil divides its aid into: (1) Merit scholarships for Gulf employees' children; (2) Gift matching, gifts by employees to eligible colleges and universities were matched by the company; (3) Faculty salary supplements; (4) Direct grants to independent colleges (650 had received aid); (5) Departmental assistance; (6) Graduate fellowships for basic research.

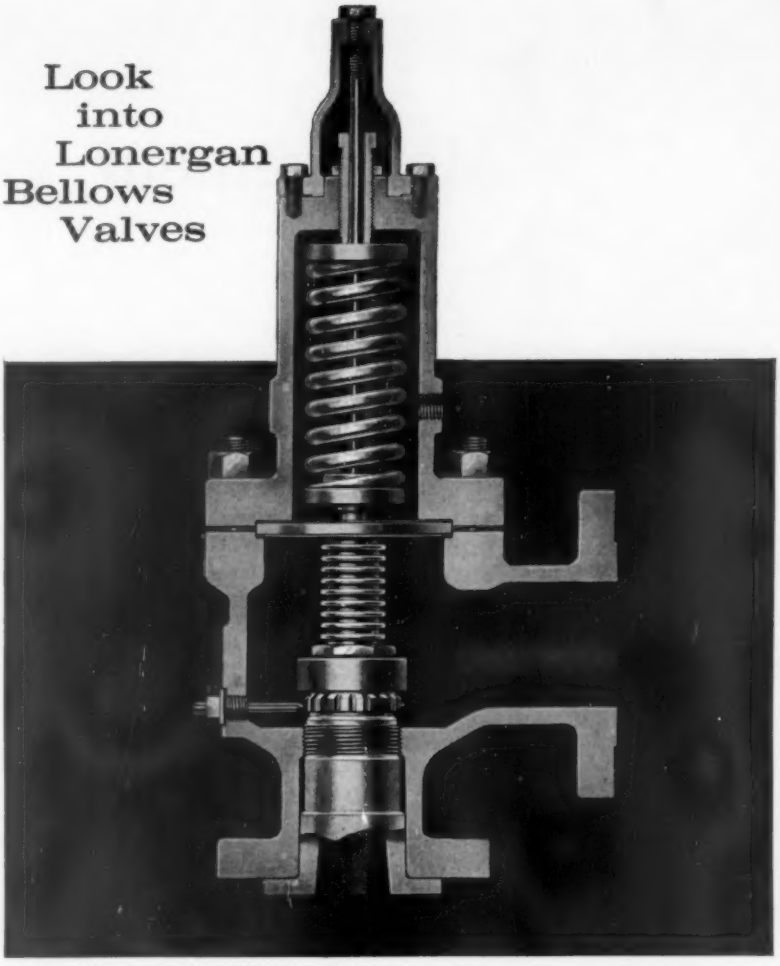
Number of shareholders continued to increase. Jersey Standard, which has the largest number, rose to 665,000, up 14% over 1959.

In proportion to number of employees, wages and benefits rose. A widespread 5% wage increase was granted by most companies.

The future will probably show a slower rate of decline in petroleum employment. Extensive reorganizations in 1960 made many surplus jobs. Automation and increased efficiencies will reduce manpower demand but expanded business will probably keep employment on an even keel.

One thing is sure — need for a higher level of education and skills will continue to grow. ■

Look into Lonergan Bellows Valves



Seven exclusive features reduce maintenance costs; provide increased valve versatility.

Like all bellows valves, Lonergan valves are designed to keep corrosive or viscous fluids away from working parts. In addition, they provide a balancing action against a variable back pressure. The similarity between Lonergan and any other bellows valve ends there. *Only Lonergan valves provide:*

1. *Saf-T-Alarm to warn of bellows failure. Alarm may be remotely located. (Optional at extra cost.)

2. Complete interchangeability with conventional valves of the same series.

3. Versatile cap arrangement. Bolted cap is standard and is interchangeable with a packed cap without taking the valve off the line or out of service. Gag facility is included.

4. *Simplified nozzle replacement due to an exclusive knockout feature. (Optional.)

5. A Hydro model; a patented, true, non-chattering liquid valve. Elimination of chatter ends bellows failure due to excessive flexing.

6. Reserve seating surface obtained from a built-in spare disc.

7. PVC trim, where pressure-temperature conditions permit.

These seven features mean economy for Lonergan valve users—in first cost; in operation; in maintenance. If your plant uses bellows valves, then it will pay you to investigate Lonergan. Series DB bellows valves are described in a new bulletin. Series D valves, available without the bellows, are also described. Write for your copy today.

**Patent Pending*

Lonergan

J. E. LONERGAN COMPANY, 205 RACE STREET
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Management People

W. L. Wolfe, vice president sales with Jones & Laughlin Supply Division, moved his office to Houston where top sales direction and sales policies are administered. R. J. Woods Jr., previously director of sales, was appointed assistant to the president at Tulsa. Bill Wood, former regional manager, Tulsa, was promoted to the newly created position of general manager, sales and V. H. Weldon Jr., former assistant manager, tubular products, was assigned as assistant to the vice president, sales, at Houston.

Vernon Frost and Jack Crawley of Frost Engineering Service Company were appointed Southern California and Western Arizona representatives for Amot Controls Corporation of Richmond, California, manufacturers of safety controls, thermostats, valves and switches.

Paul L. Chamberlain was named to the newly established position of consulting-specialist for sales at General Electric's computer department in Phoenix, Arizona. He formerly headed the coordination committee for thermoplastic recording, a new GE development for writing, storing, and reading information.

H. Wilkinson was elected a member of the board of directors of Shell Oil Company. A managing director of the Royal Dutch/Shell group of companies and of the "Shell" Transport and Trading Company, Ltd., he replaces F. J. Stephens, who resigned to accept appointment as chairman of the board of "Shell" Transport and Trading Company, Ltd.

Ronald E. Foshee Jr., former sales engineer with Parkersburg Rig and Reel Company, was appointed manager of the Midland-Odessa branch of Maloney-Crawford Tank and Manufacturing Co.

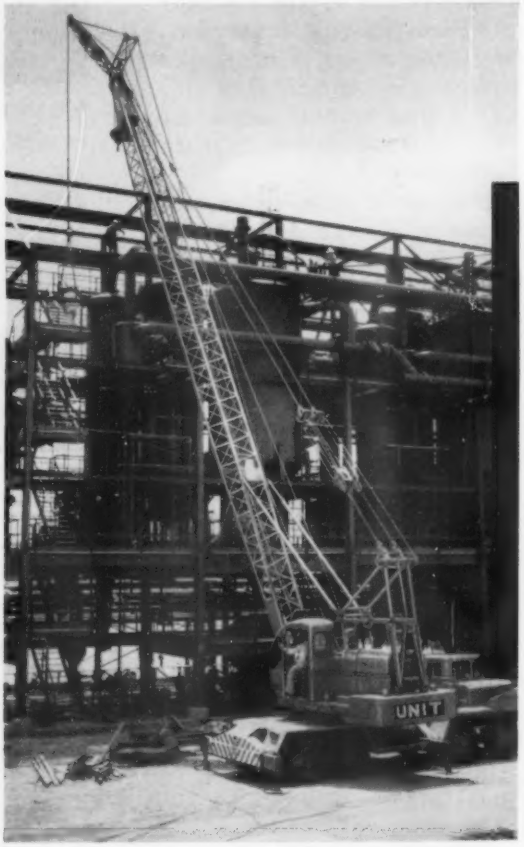
E. L. Dildine was appointed manager of crude oil purchases and sales for Standard Oil Company of Texas. He succeeded R. E. Caraway who was transferred to San Francisco to be responsible for the procurement and distribution of lube oil stocks

Let UNIT crane "Profit-Lifts" get you back on stream faster

With turnaround the largest single item of operating expense in your plant, lengthy shutdowns, while rotating equipment, are costly. That's why it is so important to get back on stream quickly — why it is so important to include a UNIT crane in your equipment handling fleet.

With their short tail swing and automotive-type power steering, UNIT cranes on rubber are able to maneuver in close quarters. "Straight-in-line" mounting of the crane's engine, worm drive and main machinery means smooth, direct power flow . . . maximum operating efficiency. Disc-type operating clutches provide uniform, positive engagement . . . loads are picked up smoothly and evenly. A fully independent boom hoist, providing power control of raising and lowering, permits extreme accuracy in load handling. And you get long-boom stability that lets you reach over existing machinery and framing to spot in new assemblies.

UNIT cranes on rubber are offered with either wagon or truck mounts. Capacities range from 10 to 40 tons. The UNIT dealer in your area will gladly give you full details.



UNIT

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for the parent company, Standard Oil of California. R. L. Mays is assistant manager, crude oil purchases and sales, succeeding Dildine.

J. W. Johnstone

James W. Johnstone succeeded Leslie A. Webb as assistant to the president of Atlantic Refining. For the past year, Johnstone has headed both mechanical and electrical engineering research in the engineering and construction department. Webb is now manager of corporate planning services.

Atlantic Refining Company's research and development department has been streamlined from five to four major divisions. New divisions and their managers are: Development—William K. Griesinger; services — John C Martin; research — Paul M. Pitts and Southwest —L. Preston Whorton, resident manager.

Position of senior scientist, extended to research people of outstanding ability, was given to two Socony scientists. They are Paul B. Weisz and Dr. Walter L. Moreman.

Robert L. Parkin, Enjay Chemical Company, was named advertising and sales promotion coordinator of the company's newly formed advertising and sales promotion organization. The new group includes Vernon G. Carrier, Charles W. Robbins Jr., Edwin L. Allen and C. H. Wingardner. Parkin works closely with Humble's advertising and sales promotion manager, Robert M. Gray.

Richard H. Danielson, with more than 15 years service in the oil industry, was promoted to assistant advertising manager of the newly expanded American Oil Company. He was formerly district manager at Joliet, Illinois.

H. Monroe Gordon was promoted supervisor of plans and benefits in the central employee relations department of the newly expanded American Oil Company, national marketing and manufacturing affiliate of Standard Oil Company (Indiana). Lance Jeffers joined the public relations department of American Oil as a staff writer in the general office at Chicago.

John J. Hall, director of the Esso Safety Foundation, retired after having held this position since 1954. His pioneering programs in traffic safety have been adopted throughout North America, and in other parts of the world. He developed and promoted the first statewide motor-vehicle inspection and high school driver education programs in the United States, is one of the founders of the American Association of Motor Vehicle Administrators, and organized the national street and highway safety program of the American Legion.

A. S. C. Hulton, former director of Shell International Petroleum Company, Ltd., and its coordinator for Africa and Middle East, was elected president and a director of Asiatic Petroleum Corporation in succession to David H. Barran on the latter's appointment as a man-

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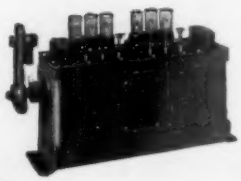


ask the man from

A UNIT OF HOUDAILLE INDUSTRIES, INC.

Manzel

SPECIALISTS IN LUBRICATORS AND METERING PUMPS SINCE 1898

aging director of the Royal Dutch/Shell group in London. Hulton was also appointed a director of Shell Caribbean Petroleum Company and chairman of the executive committee of the board. Succeeding Barran as president of Shell Caribbean Petroleum Company is John A. Walstrom, former vice president and a director since 1957. J. H. French, former treasurer and a director was elected vice president.

Lewis W. MacNaughton and J. Edgar Heston were elected members of the board of directors of Cities Service Company. MacNaughton is chairman of the board of DeGolyer and MacNaughton and Heston is president and a director of Cities Service Petroleum.

Carroll J. Brown joined Socony Mobil in the newly created position of executive development advisor. He had filled a similar post with Standard Vacuum Oil Company.

Burton F. Wiand, vice president and director of Cities Service Gas Company, Oklahoma City, was transferred to the parent Cities Service Company in New York City where he will coordinate industrial relations and public affairs for the organization.

Raymond A. Durand, former sales manager, was named vice president, sales, for Edward Valves, Inc., subsidiary of Rockwell Manufacturing Company.

H. D. Galloway was elected chairman of the board of directors of A/S Esso Raffineriet Norge, the Norwegian refining affiliate of Standard Oil Company (New Jersey). In addition to his new position he continues as a director and vice chairman of A/S Norske Esso, Jersey's Norwegian marketing affiliate.

Hal W. Stewart, general counsel and member of the board of directors of The Ohio Oil Company, retired after 39 years service. He was succeeded by Clayton L. Orn, former general attorney. C. A. Brown and W. K. Tell, members of the company's legal department, were appointed to positions of general attorney.

N. T. Bogart

P. N. Johnson

J. T. Higgins

Three major changes in top management of Standard Oil of California's refining and manufacturing activities are: J.T. Higgins now associated with G. A. Davidson, vice president and director and chief functional officer in charge of manufacturing, engineering and research; N. T. Bogart succeeded Higgins as vice president, general manager of the manufacturing department of Standard's Western Operations, Inc.; and P. N. Johnson, previously vice president, California Oil Company, Western Division, succeeded Bogart as assistant general manager of Western Operations' Manufacturing Department.

Reid Brazell, president of the National Petroleum Refiners Association, was designated to ex-officio membership on the National Petroleum Council. The newly formed National Petroleum Refiners Association resulted from the merger of the National Petroleum Association and the Western Petroleum Refiners Association.

William L. Owen was appointed general counsel of the Arabian American Oil Company, succeeding George W. Ray Jr., who acts as a consultant. Owen formerly served as counsel for Trans-Arabian Pipe Line before joining Aramco. His headquarters are in Dhahran, Saudi Arabia.

R. Wayne Tilton, KLM Royal Dutch Airlines, former international petroleum representative in the market development department in New York City, was transferred to Houston, Where his task is general sales, with specific emphasis on the oil industry .

D. B. Kemball Cook, former Shell executive vice president for exploration and production, was appointed executive vice president to coordin-

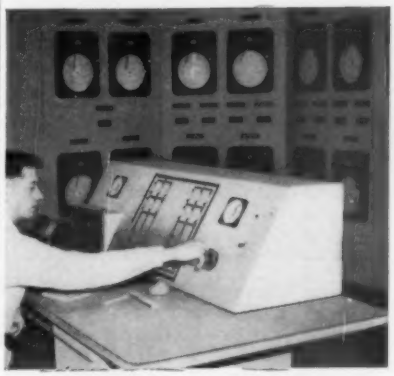
COUPLINGS

LINE PIPE COUPLINGS A. P. I.
⅛" to 16"—Seamless, Black or Galvanized
PLAIN TUBING COUPLINGS A. P. I.
1" to 4"—Seamless
EXTERNAL UPSET TUBING COUPLINGS A. P. I.
¾" to 4"—Seamless
CASING COUPLINGS A. P. I.
4½" to 13⅜"—Long or Short
HYDRAULIC COUPLINGS
⅛" to 4"—Seamless
REAMED AND DRIFTED A. I
1" to 12"—Seamless
DRIVE PIPE COUPLINGS
6" to 12"—Seamless
PIPE NIPPLES
All Sizes and Types
STEEL BUSHINGS AND PLU
Merchant and High Pressure

Your Order Is SHIPPED SAME DAY We Receive It

WHEELING MACHINE PRODUCTS CO. Wheeling, West Virginia
West Coast Factory: Woodlake, California

AUTOMATION ECONOMY



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ate marketing, manufacturing, purchasing-stores, and transportation and supplies, and as the president's deputy. Succeeding Kemball Cook is J. E. Clark, former vice president, production. Both men are members of the board.

Robert W. Hines of Fort Worth, former vice president of production for Texas Pacific Coal and Oil Company, was elected executive vice president of the company.

Dr. Fritz Lony, former deputy member, was appointed regular member of the managing board of Mobil Oil AG in Deutschland at Hamburg.

George A. Lawrence, manager of the public relations department of Imperial Oil, Ltd., was appointed deputy director of public relations for Jersey Standard. Imperial is Jersey's Canadian affiliate.

J. M. Crouch was named assistant manager for Humble Oil & Refining Company's headquarters general services department. Other appointments include: J. W. Perry, head of the administrative section; J. B. Turner Jr., head of the engineering section; G. L. McGonigle, building manager and head of the office building section and W. W. Dent, head of the stationery, printing and reproduction section.

Appointments to the employee relations department, Southeast region, are: John R. Baldwin, new field services coordinator; Homer O. Gainer, salary and wage coordinator; Sidney E. Kuehn, annuities and benefits; and T. G. Larimer, employment services. They are responsible to William Grant Jr., employee relations manager.

Harold G. Osborn, Houston, 40-year employee, director and senior vice president of Continental Oil Company, retired. He is a widely known petroleum industry executive, and has been responsible for the company's research and development, petrochemical, and engineering activities. In 1960 he received an honorary doctor of science degree from the University of Tulsa for "distinguished service to education." He also is chairman of the board of directors of Continental Carbon Company and Petroquimica Argentina, S.A. (PASA).

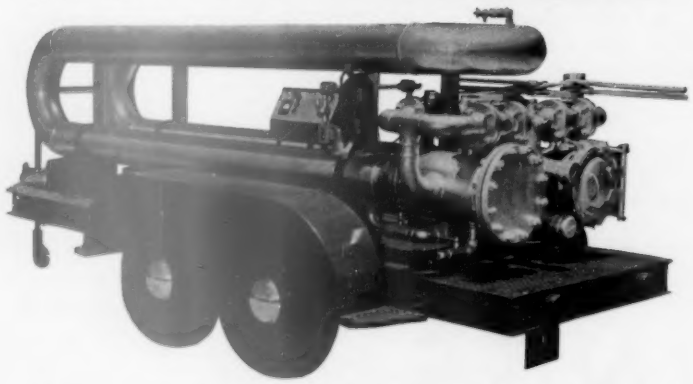
J. E. Roth, Tidewater Oil Company senior vice president, assumed new responsibilities and more directly assists the president in directing the company's activities. Charles R. Brown, vice president and general manager of the western division, was appointed a member of executive management and is group vice president for exploration and production activities. James McDonald, assistant western division general manager, was promoted to vice president and succeeds Brown as western division general manager. George M. Dixon was appointed manager, western division trade relations.

Jess C. Evans Jr. of Bartlesville, former cashier for Cities Service Petroleum Company, was elected an assistant treasurer.

W. D. Dowden was named to the new post of manager, regulatory gas accounting, Sun Oil Company, to direct increasing accounting requirements resulting from the Federal regulation of natural gas.

POSITIVE DISPLACEMENT

METER PROVERS



Maloney's Bi-Directional Trailer-Mounted Meter Prover . . .

. . . is the latest solution to fast, accurate liquid meter proving. Ideal for proving LACT or other widely separated meters, this portable prover is precision-built under constant engineering supervision, calibrated and certified. The rugged-built trailer meets ICC safety requirements and provides maximum mobility on highways and on rugged terrain.

Maloney meter provers offer:

Speed . . . One operator can prove an LACT unit in 15 or 20 minutes.

Accuracy . . . The majority of Maloney provers have experienced from .01 to .02 of 1% repeatability.

Ease of Operation . . . Meters are proved on stream under true operating conditions using actual line fluid. No prover tanks are necessary.

Economy . . . Savings are realized in the amount of time and number of personnel necessary to prove meters and in the expense of the equipment needed.

The trailer-mounted prover is one of five standard models built by the F. H. Maloney Company. Others are the Skid-Mounted Bi-Directional, the U-Bend, the Interchange and Loop Assembly, and the Interchange Unit. Also, the Maloney Company can design and build provers to meet other particular specifications. The Company has an Engineering Design Service to solve meter proving problems, including those of design, fabrication, or installation. For a complete description of Maloney Meter Provers and Design Service, please write the Company's Houston office for Bulletins MP-1 and MP-2.

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Meetings

Sept. 12-14—National Petroleum Assn., annual, Traymore Hotel, Atlantic City, N. J.

Sept. 13-15—Mid-Continent Oil & Gas Assn., Lou.-Ark. Div. 39th annual, The Roosevelt Hotel, New Orleans, La.

Sept. 13-15—PCGA, convention and annual meeting, Coronado Hotel, Coronado, Calif.

Sept. 14—Natural Gasoline Assn. of America, Rocky Mountain regional, Northern Hotel, Billings, Mont.

Sept. 14-15—ASME-AIEE, engineering management conf., The Roosevelt Hotel, New York City.

Sept. 17-20—American Institute of Electrical Engineers, annual electrical conf. of the petroleum industry, Jung Hotel, New Orleans, La.

Sept. 20-21—Western Petroleum Refiners Assn., Rocky Mountain regional technical-industrial meeting, Henning Hotel, Casper, Wyo.

Sept. 24-27—ASME, petroleum mechanical engineering conf., Hotel Muehlebach, Kansas City, Mo.

Sept. 24-28—ASTM Committee, D-2 meeting, Statler Hotel, Detroit, Mich.

Sept. 25-27—Texas Mid-Continent Oil & Gas Assn., 42nd annual, Texas Hotel, Fort Worth, Tex.

Sept. 25-28—American Welding Society, fall meeting, Adolphus Hotel, Dallas, Tex.

Oct. 1-4—AGA, annual convention, Dallas, Tex.

Oct. 4-6—American Assn. of Oilwell Drilling Contractors, 21st annual, Rice Hotel, Houston.

Oct. 4-6—ASME, process industries conf., Shamrock-Hilton Hotel, Houston.

Oct. 8-11—Society of Petroleum Engineers of AIME, 36th annual fall meeting, Memorial Auditorium, Dallas.

Oct. 17-19—ASME-ASLE, lubrication conf., Morrison Hotel, Chicago, Ill.

Oct. 18-20 — Rocky Mountain Oil & Gas Assn., 16th annual convention, Denver-Hilton Hotel, Denver, Colorado.

Oct. 18-21 — The American Assn. of Petroleum Geologists, Mid-Continent regional, Amarillo, Texas.

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No heat freeze. Temp. range -350°F to +2987°F
MEETS GOVERNMENT SPECIFICATIONS
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NO GALLING OR SEIZING recommended for aluminum, stainless, titanium, plastic, steel, brass, etc.
HIGH PRESSURE SEALANT a real thread sealer, pressures held to 50,000 psi hydraulic fluids, 3500 psi air, 1000 psi gases. Has UL approval. For gases, steam, air, ammonia, hydraulic fluids.
CORROSION PROTECTION no corrosion weld, prevents fretting, acid-etch, etc.

CORROSION
FREE THREAD

SEND FOR FREE SAMPLE!
APPROVED for Butane, Propane, Gasoline, Petroleum Oils.
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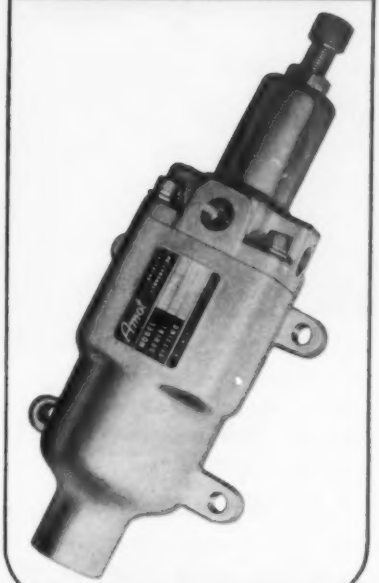
DETECT AND STOP EXCESSIVE VIBRATION
WITH
Amot MODEL 2900 VIBRATION VALVE

Amot Model 2900 Vibration Valve detects and trips on excessive vibration of reciprocating or rotating machinery, such as engines, compressors, motors, fans, pumps.

It is offered as an accessory to Amot Series 1476 Safety and Automatic Controls.



FEATURES: Duty: For Pneumatic or Hydraulic Control Systems to 80 psi.
Operation: Three-way, snap acting, non-overlap valve action.
Range: Adjustable to amplitudes between .004" and .050" at 250 cpm and between .003" and .023" at 700 cpm or higher.
Reset: Built-in piston to reset control with 45-80 psi air; also provides means for time delay on start-up.

Write for Bulletin 493

Amot controls
CORPORATION
THERMOSTATS CONTROLS SWITCHES VALVES SAFETY CONTROLS

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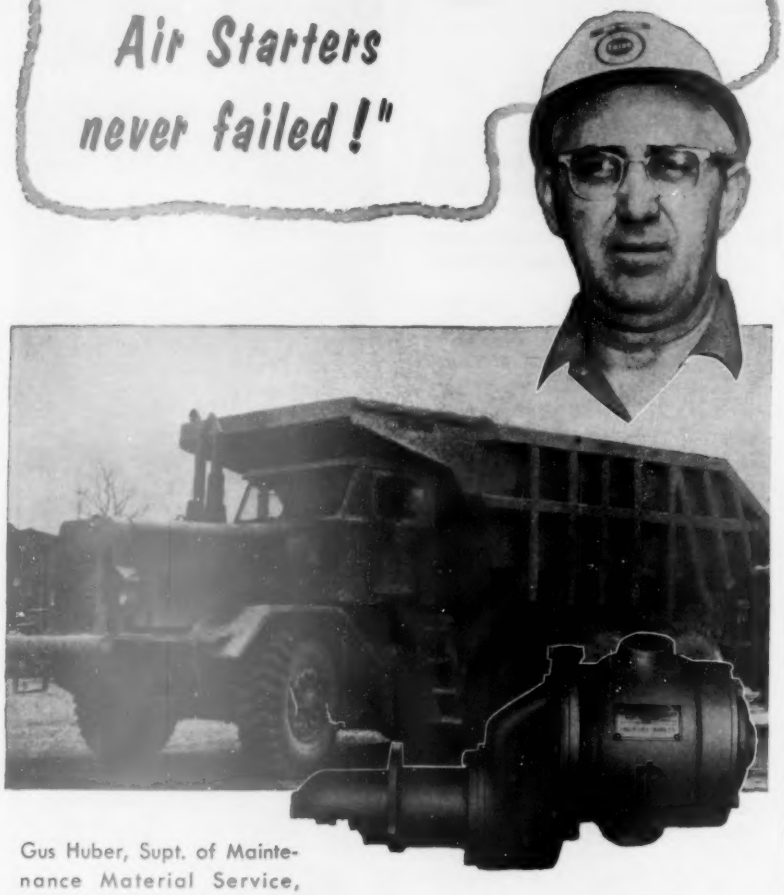
"over 11,000 hours on-the-job... Air Starters never failed!"



Gus Huber, Supt. of Maintenance Material Service, Chicago, Illinois, has this to say about Air Starters . . .

"We have Size 20BM Ingersoll-Rand Air Starters on eight of our big Dart dump trucks. These heavy-duty units have been in use for four years and each truck has recorded over 11,000 hours on-the-job. During this time, including the coldest weather, not one of these trucks has ever had a starting failure, and no repairs were necessary!"

Reduce electrical maintenance to an absolute minimum by using modern Ingersoll-Rand Air Starters. They produce surer, faster starts and are unaffected by extreme weather conditions.

Ingersoll-Rand Starters are made in 4 sizes for starting diesel, or carbureted engines from 300 cu. in. to 20,000 cu. in. displacement. For complete information on these efficient starters . . . write for your copy of "Go Modern—Start with Air," Form 5094E.

Ingersoll-Rand

223A-18

11 Broadway, New York 4, N. Y.

Laugh with Barney

At a recent oil convention, a rather glum looking oilman walked into a woman's dress shop and silently handed a saleslady a slip of paper which read:

"To whom it may concern: Since I am tired of returning black nightgowns, off-the-shoulder blouses and similar articles after every convention, and since the bearer of this note seems to think I am exactly the size of the current salesperson, here are some statistics and information: I am five-feet-three-inches tall, weigh 135 lb, wear a size 13 dress and size 10 stocking. I do not like the color green, wide stripes, polka dots or nylons without seams. Please do not sell him the most expensive gift in the store as we have to eat the next week, too. Thanking you in advance, I am sincerely, Wife of the bearer."

"Aw, baby, where's your heart?" he pleaded.

"Straight down my throat, first turn to the left."

A bit stumped by the case at hand the doctor told the young lady, "You've either got a cold or you're pregnant."

"I must be pregnant," decided the patient. "I don't know anybody who could have given me a cold."

A fellow was going in for a landing on Mars when he spotted a gorgeous nude blonde. When the rocket came to a halt, he threw open the door in keen anticipation and rushed toward the enchantress.

Much to his dismay, she was 20 ft. tall.

"Take me to your ladder," he stammered. "I'll see your leader later."

A husband that is as busy as a bee may wake up one day and find his honey gone.

Sign seen at filling station: "Fill your car and drain your family."

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8" and 10" used or new surplus steel pipe couplings, 8 THD. with or without Dutchmen, any quantity, any area. Immediate inspection and prompt pickup with our trucks. Write, wire or phone collect.

GEORGE BARBER

VALLEY STEEL PRODUCTS CO.

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A young lady on a vacation cruise stopped a sailor at his job and asked, "I'd like to see the captain of this ship."

"He's forward, Miss."

"Well, I don't mind. This IS a pleasure trip."

Life's an everlasting struggle to keep money coming in and teeth and hair from coming out.

A Texas millionaire drove his air-conditioned Cadillac to New York. Approaching the George Washington bridge he got into a hassle with the gate keeper about the 50 cent toll.

"Son," he drawled, "I never carry anything less than a $500 bill. How much do you want for the bridge?"

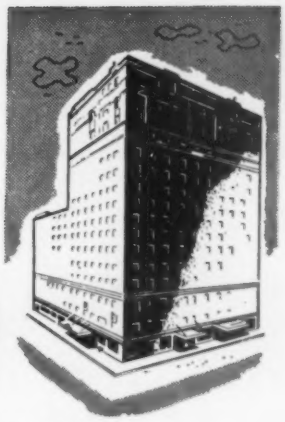
Eli Whitney's instructions to his son: "Keep your cotton-pickin' fingers off my gin."

"Every night," complained the spinster to her doctor, "my sleep is disturbed by dreams of a young man who persistently chases me." The doctor gave her some pills, which he guaranteed would give her dreamless sleep, but in a few weeks she was back.

"Didn't the pills work?" asked the doctor. "Oh, I sleep fine," answered the lady, "But I do miss that young man."

A drunk approached a large hotel in the windy city, Chicago, just as a gust of wind spun the revolving doors. The drunk stepped back, looked up at the tall building, turned to the doorman and said, "He'll never get it off the ground."

The Beautiful Lamar



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General Manager

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600 Bright *Reasonably* Priced Rooms

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Sample Rooms – Finest Food
Adjacent Garage

Energy in the USA, 1975

The United States in 1975 could satisfy its demands for all energy, and for each of the energy materials of which the total is composed, from domestic sources of supply. This is the conclusion of Sam H. Schurr and Bruce C. Netschert (with Vera F. Eliasberg, Joseph Lerner, and Hans H. Landsberg) in "Energy in the American Economy, 1850-1975." The study adds this is possible at no significant increases in costs, except for inflation.

Fuel Policy Not Needed

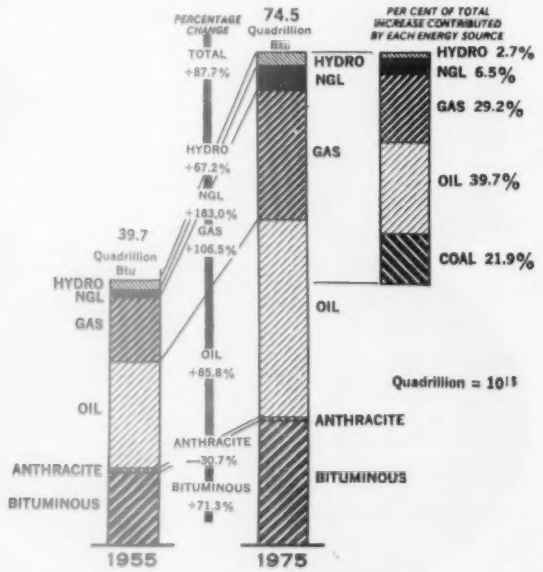
The findings make it clear that the United States is not compelled to adopt particular policies, as is sometimes contended, because of impending resource exhaustion in any of the mineral fuels, or the threat of steeply rising costs. Thus decisions on such policy questions can be reached on their individual merits and calmly, not in an atmosphere charged with apprehension about the country's ability to satisfy its future needs at reasonable costs.

The book contains an interpretative summary and three main parts, plus detailed appendices of supporting statistics. Part I deals with the past century of energy use.

Part II deals with the future of energy consumption in total, and in terms of its composition among the different fuels and electricity and its pattern of use among consuming sectors.

In Part III the future of energy supply is examined in terms of the nation's reserve and resource position in coal, crude oil, natural gas, natural gas liquids and hydropower. Their potential availability in 1975 is estimated in light of the natural resource position and the prospects for technological advance.

Total energy use in the United States grew between 1900 and 1955 at an annual average rate of 3.1%. Between 1955 and 1975 energy consumption is projected to grow at an average annual rate of 3.2%.



The energy source mix, 1955 and estimated 1975. From Energy in the American Economy, 1850-1975.

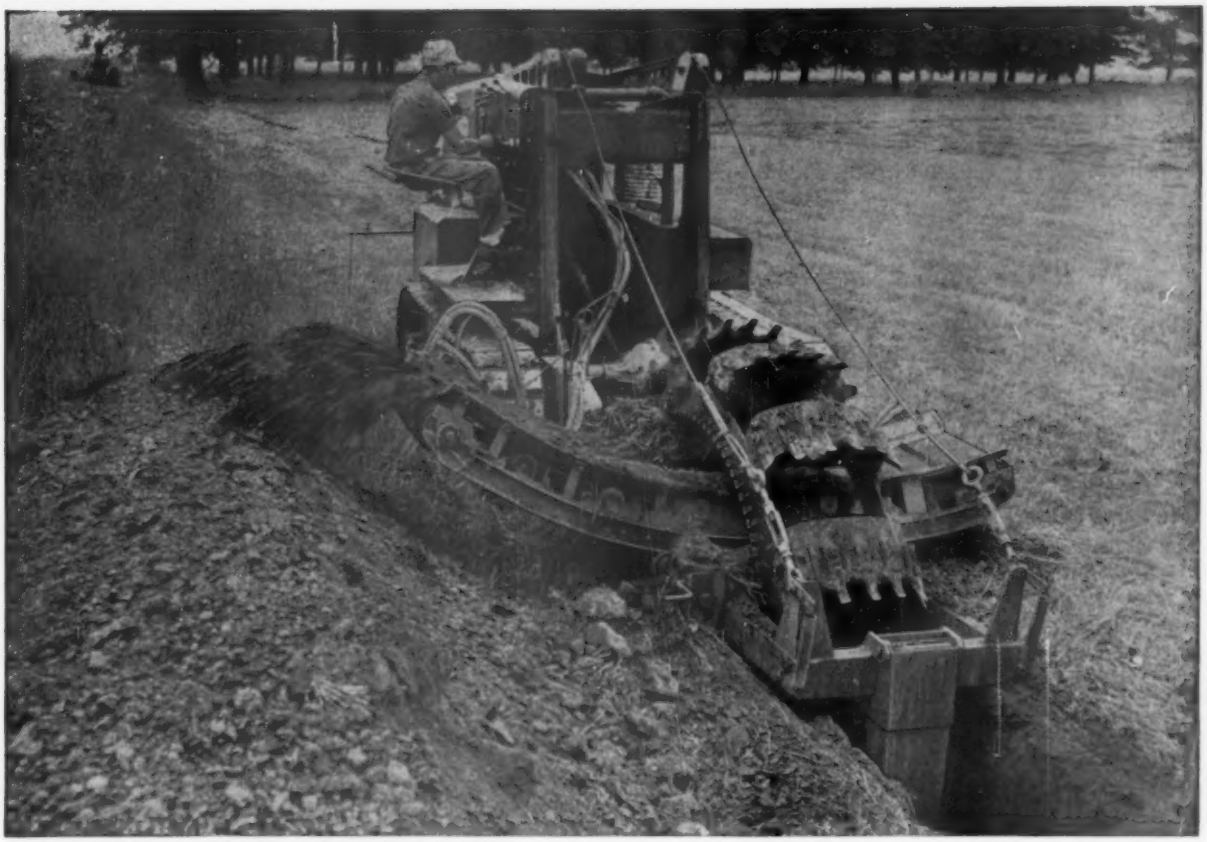
Energy Pattern Stable

The pattern of energy use since 1850 shows two great developments: the replacement of fuel wood by coal as the major energy source, and the subsequent replacement of coal in turn by petroleum and natural gas. No such sharp changes are expected in the energy source pattern between 1955 and 1975. (See graph.)

No projection to 1975 is made for atomic energy because of the lack of an adequate basis at this time on which to make an estimate.

Nevertheless, since coal is expected to be the chief source of electric power in 1975, as it is today, the emergence of commercial atomic power on a significant scale will be largely at the expense of coal.

The 796-page book, priced at $12.50, was published for Resources of the Future by the Johns Hopkins Press, Baltimore 18, Maryland. ■



Barber-Greene Model 774 Wheel Ditcher—with its many new, exclusive advantages—digs accurately to grade as it sets production records on new superhighway drainage ditch. Write for new bulletin.

Why this rugged Barber-Greene digs up to 25% more trench per day

These exclusive Barber-Greene advantages enable the Model 774 Wheel Ditcher to produce up to 25% more ditch per day than any machine of its size:

- **New Dual Range Hydra-Crowd Transmission** provides infinitely variable crowding speeds independent of wheel and conveyor drives. No stopping to change speeds . . . no gear shifting. Instant selection of maximum crowding speeds for every digging condition.
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CONVEYORS • LOADERS • DITCHERS • ASPHALT PAVING EQUIPMENT

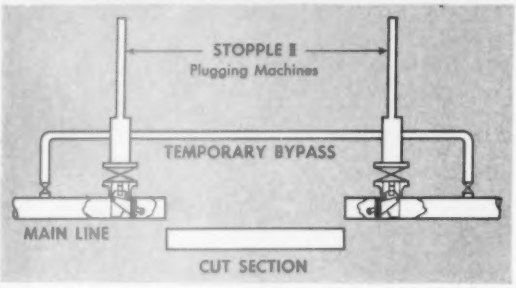
Global Data on 135 Areas

Most figures tabulated here come from government agencies or from operating companies. Communist data are from published official sources. Reserve figures were scaled down as Red China claims 20 billion barrels and USSR states it has 80 billion barrels reserves. We do feel outside estimates of Communist reserves are too low but Red claims are obviously high. We suggest these two pages be filed for future reference.

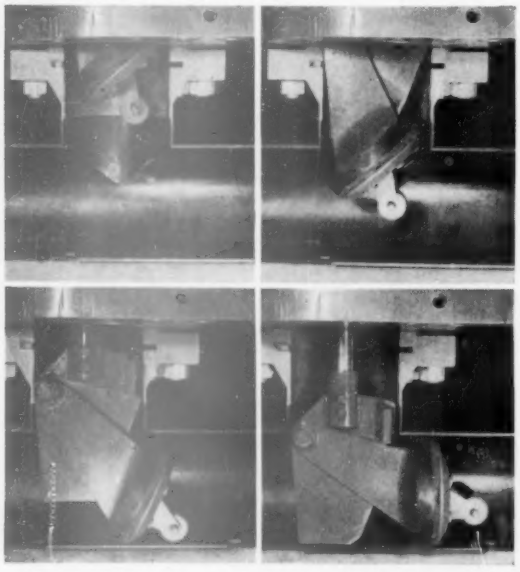
Geographic area	Rotary rigs 12/31/60	Wells drilled	Production: Crude & LPG avg. b/d	Production: % chg. from 1959	Production: Gas average mcf/d	Refining: No. plants	Refining: Crude capacity b/d	Refining: Runs average b/d	Inland consumption b/d	% chg. from 1959	Reserves[c] Latest data: Million bbl oil	Reserves[c] Latest data: Billion cu ft gas
NORTH AMERICA												
Alaska	7	25	1,600	+146	—	0	—	—	17,500	+ 19	—	—
Canada	176	2,536	524,168	+ 4	1,635,358	43	947,700	757,848	847,127	+ 2	4,217	30,674
Hawaii	—	—	—	—	—	1	35,000	32,000[1]	35,260	+ 9	—	—
Mexico	158	726	297,190	+ 3	932,536	7	450,700	293,113	288,896	+ 7	2,763	11,300
United States	1,863	46,500	7,977,430	+ 1	35,864,000	303	9,986,350	8,073,000	9,421,500	+ 2	38,400	263,800
TOTAL N. AMERICA	2,204	49,787	8,822,231	+ 1	38,431,894	354	11,419,750	9,155,961	10,610,283	+ 2	45,380	305,774
CENTRAL AMERICA AND CARIBBEAN												
Bahama Islands	—	—	—	—	—	—	—	—	1,250	0	—	—
Barbados	—	—	—	—	—	1	1,000	800	800	0	—	—
Br. Honduras	2	2	—	—	—	—	—	—	3,000	0	—	—
Costa Rica	1	2	—	—	—	—	—	—	3,150	0	—	—
Cuba	5	10	300	— 40	—	6	88,400	70,000	74,000	+ 10	2	—
Dominican Rep.	1	2	—	—	—	—	—	—	7,140	— 3	—	—
El Salvador	—	—	—	—	—	—	—	—	4,500	+ 1	—	—
Fr. West Indies[2]	—	—	—	—	—	—	—	—	3,000	+ 9	—	—
Guatemala	1	2	—	—	—	—	—	—	9,100	+ 10	—	—
Haiti	—	—	—	—	—	—	—	—	1,320	+ 10	—	—
Honduras	—	—	—	—	—	—	—	—	5,200	+ 15	—	—
Jamaica	1	—	—	—	—	—	—	—	12,700	+ 15	—	—
Nicaragua	—	—	—	—	—	—	—	—	2,970	+ 7	—	
Panama (Canal Zone)	—	—	—	—	—	—	—	—	2,636	— 15	—	—
Panama Republic	1	—	—	—	—	—	—	—	7,693	0	—	—
Puerto Rico	1	2	—	—	—	2	100,000	73,100	50,000	+ 10	—	—
TOTAL C.A. & CARIB.	13	20	300	— 40	—	9	189,400	143,900	188,459	+ 8	2	—
SOUTH AMERICA												
Argentina	98	852	175,340	+ 43	50,000	14	252,000	233,000	216,000	+ 5	3,150	706
Bolivia	20	46	9,765	+ 13	5,010	5	12,400	6,194	5,742	0	100	27
Brazil	62	238	80,909	+ 23	51,495	9	208,000	180,000	256,570	+ 13	665	500
British Guiana	—	—	—	—	—	—	—	—	3,000	+ 20	—	—
Chile	4	56	20,000	+ 13	—	2	45,200	27,000	42,000	+ 4	100	—
Colombia	32	173	152,378	+ 4	226,198	5	75,000	67,866	54,964	+ 12	700	—
Ecuador	6	64	7,670	— 1	—	2	13,700	11,600	9,700	+ 6	15	—
Netherlands W. I.	—	—	—	—	—	2	650,000	765,000	2,000	+ 7	—	—
Paraguay	—	—	—	—	—	—	—	—	2,222	+ 12	—	—
Peru	11	145	55,282	+ 7	107,500	3	47,300	45,200	48,400	+ 9	382	727
Trinidad	27	312	121,595	+ 4	267,540	2	285,000	223,806	6,833	+ 16	425	—
Uruguay	—	—	—	—	—	1	28,000	27,000	25,879	0	—	—
Venezuela	39	444	2,846,107	+ 3	2,765,000	15	1,003,500	882,283	80,648	+ 8	17,354	33,300
TOTAL S. AMERICA	299	2,330	3,469,046	+ 7	3,472,843	60	2,620,100	2,468,949	753,958	+ 9	22,891	35,260
WESTERN EUROPE												
Austria	14	94	49,000	0	143,700	6	53,000	40,000	55,700	+ 17	252	900
Belgium	—	—	—	—		6	170,000	139,000	133,000	+ 12	—	—
Denmark	—	—	—	—	—	4	4,700	4,094	98,592	+ 12	—	—
Finland	—	—	—	—	—	1	25,000	23,718	46,600	+ 24	—	—
France	28	242	39,100	+ 22	425,000	14	805,000	658,000	465,000	+ 11	200	7,000
Germany (West)	88	451	107,274	+ 8	43,221	24	854,695	608,190	561,000	+ 25	625	900
Greece	1	0	—	—	—	1	30,000	36,700	40,055	+ 4	—	—
Ireland	—	—	—	—	—	1	39,600	26,000	20,480	+ 1	—	—
Italy, (Sicily)	50	241	40,000	+ 17	614,400	35	780,000	630,000	369,000	+ 22	300	310
Malta	—	—	—	—	—	—	—	—	3,300	0	—	—
Netherlands	4	16	36,236	+ 8	18,000	3	459,000	374,000	164,000	+ 14	200	—
Norway	—	—	—	—	—	1	2,200	1,900	66,000	+ 9	—	—
Portugal	1	1	—	—	—	1	24,000	25,000	34,000	+ 3	—	
Spain	9	14	—	—	—	2	190,000[3]	84,600	90,000	+ 5	—	—
Sweden	—	—	—	—	—	5	67,100	53,400	250,000	+ 14	—	—
Switzerland	3	5	—	—	—	—	—	—	77,915	+ 19	—	—
United Kingdom	6	41	1,750	+ 3	135	17	1,027,000	914,000	860,000	+ 16	5	—
Yugoslavia	20	92	25,836	+ 52	5,274	3	30,000	26,000	25,700	+ 5	145	—
TOTAL W. EUROPE	224	1,197	297,196	+ 13	1,249,730	126	4,561,295	3,644,602	3,360,342	+ 16	1,727	9,110
AFRICA												
Algeria	2	3	100	—	—	—	—	—	32,000	+ 16	1	1
Angola	4	15	1,300	+ 33	284	1	4,000	3,600	4,980	+ 24	30	—
Cameroun	—	—	—	—	—	—	—	—	2,800	—	—	—
Central Africa Rep.	—	—	—	—	—	—	—	—	1,000	—	—	—
Congo, Rep. of	1	8	1,670	+ 13	—	—	—	—	1,200	—	6	14
Congo, Rep. of the	—	—	—	—	—	—	—	—	8,800	— 12	—	2,000
Egypt (UAR)	16	50	62,182	+ 5	—	3	96,000	79,000	94,400	+ 1	500	—
Ethiopia	—	—	—	—	—	—	—	—	2,614	+ 1	—	—
French Sahara	41	184	182,700	+562	18,700	—	—	—	100	+ 25	4,500	45,000
Gabon	5	35	16,600	+ 24	720	—	—	—	2,800	—	46	159
Gambia	1	—	—	—	—	—	—	—	100	+ 1	—	—

[1]At end of year. [2]Martinique, Guadeloupe, etc. [3]Bunkers add 1,465,000 b/d. [c]Estimate.

Geographic area	Rotary rigs 12/31/60	Wells drilled	Production: Crude & LPG avg. b/d	% chg. from 1959	Production: Gas average mcf/d	Refining: No. plants	Refining: Crude capacity b/d	Refining: Runs average b/d	Inland consumption b/d	% chg. from 1959	Reserves[c] Latest data: Million bbl oil	Reserves[c] Latest data: Billion cu ft gas
AFRICA—Continued												
Ghana	—	—	—	—	—	—	—	—	8,767	+ 20	—	—
Ivory Coast	1	1	—	—	—	—	—	—	150	—	—	—
Kenya	1	2	—	—	—	—	—	—	2,670	+ 3	—	—
Liberia	—	—	—	—	—	—	—	—	1,100	—	—	—
Libya	34	131	—	—	—	—	—	—	3,335	+ 16	2,000	—
Malagasy Rep.	2	6	—	—	—	—	—	—	2,580	+ 9	—	—
Mali, Fed. of	1	7	35	—	—	—	—	—	3,320	+ 1	—	—
Morocco	5	9	1,920	—	910	1	4,800	4,400	16,000	+ 10	10	20,000
Mozambique	—	—	—	—	—	1	12,000	—	3,000	+ 7	—	—
Nigeria	5	33	17,396	+ 55	—	—	—	—	10,000	+ 3	150	
Portuguese Guine	1	1	—	—	—	—	—	—	120	—	—	—
Rhodesia/Nyasaland	—	—	—	—	—	—	—	—	12,000	+ 1	—	—
Somali Republic	2	4	—	—	—	—	—	—	800	+ 10	—	—
Spanish Sahara	1	2	—	—	—	—	—	—	100	—	—	—
Sudan	—	—	—	—	—	—	—	—	7,475	+ 5	—	—
Tanganyika	—	—	—	—	—	—	—	—	7,300	+ 33	—	—
Togo	—	—	—	—	—	—	—	—	600	+ 4	—	—
Tunisia	—	—	—	—	650	—	—	—	9,616	+ 15	—	—
Union of S. Africa	—	—	—	—	—	1	26,000	25,200	72,700	+ 3	—	—
TOTAL AFRICA	123	491	283,903	+143	21,264	7	142,800	112,200	312,427	+ 5	7,243	67,174
MIDDLE EAST												
Aden	—	—	—	—	—	1	120,000	85,002	465	—	—	—
Afghanistan	2	2	—	—	—	—	—	—	1,400	+ 27	—	—
Bahrain	2	1	45,083	—	—	1	186,500	208,000	1,300	—	300	—
Cyprus	—	—	—	—	—	—	—	—	4,194	— 6	—	—
Iran	11	18	1,048,000	+ 14	—	3	497,000	430,000	70,000	+ 18	40,000	—
Iraq	10	31	900,780	+ 6	—	6	59,600	44,000	26,000	+ 4	25,000	—
Israel	7	14	2,500	—	—	1	85,000	30,000	58,000	+ 5	35	—
Jordan	1	1	—	—	—	1	6,500	3,600	5,600	+ 12	—	—
Kuwait	5	22	1,623,711	+ 17	—	1	190,000	177,439	5,100	+ 9	60,000	—
Lebanon	1	1	—	—	—	2	24,000	18,600	15,720	— 5	—	—
Muscat-Oman-Dhofar	2	3	—	—	—	—	—	—	—	—	—	—
Neutral Zone	4	80	136,521	+ 30	—	1	50,000	29,114	7,800	+ 12	6,000	—
Qatar	2	2	172,370	+ 2	—	1	600	592	592	+ 15	2,500	—
Saudi Arabia	3	17	1,247,140	+ 14	750,000	1	189,000	224,894	12,800	+ 6	45,600	—
Syria (UAR)	3	6	—	—	—	1	20,000	16,600	15,600	— 15	58	
Trucial (Abu Dhabi)	2	3	—	—	—	—	—	—	50	—	20	—
Turkey	14	35	7,598	— 4	—	1	6,500	6,830	30,000	— 3	84	
TOTAL MID. EAST	69	236	5,153,703	+ 13	750,000	21	1,434,700	1,274,671	252,621	+ 8	179,597	—
FAR EAST & OCEANIA												
Australia	4	29	—	—	—	7	246,003	228,700	228,502	+ 11	—	—
British Borneo	6	16	95,000	— 14	145,000	1	46,000	46,000	2,300	+ 15	500	3
Burma	3	38	9,800	+ 2	—	2	10,200	10,000	9,100	+ 13	43	—
Cambodia	—	—	—	—	—	—	—	—	2,800	+ 12	—	—
Ceylon	—	—	—	—	—	—	—	—	12,600	+ 10	—	—
Formosa	6	9	43	+ 9	2,300	1	35,000	22,000	14,100	+ 8	—	—
India	9	25	9,100	+ 1	—	4	129,000	128,000	144,000	+ 12	500	700
Indonesia	30	153	414,800	+ 10	330	5	278,800	237,000	61,300	+ 6	9,000	—
Japan	23	248	9,900	+ 31	70,739	27	656,991	525,000	492,000	+ 38	70	15,000
Korea (South)	—	—	—	—	—	—	—	—	12,877	+ 16	—	—
Laos	—	—	—	—	—	—	—	—	700	—	—	—
Malaya	—	—	—	—	—	—	—	—	24,100	+ 30	—	—
New Caledonia	—	—	—	—	—	—	—	—	1,118	+ 10	—	—
New Guinea (Neth)	2	7	4,200	— 11	—	—	—	—	225	—	200	—
New Zealand	2	2	13	— 11	—	1	60	16	35,650	+ 11	—	—
Pakistan	7	10	7,200	+ 14	60,000	1	7,100	7,000	45,000	+ 8	22	14,000
Papua	1	1	—	—	—	—	—	—	300	—	—	—
Philippines	4	31	—	—	—	1	25,000	25,945	47,311	— 3	—	—
Singapore	—	—	—	—	—	—	—	—	12,100	+ 5	—	—
Thailand	1	—	200	—	—	1	1,000	800	23,800	+ 10	—	—
Timor (Port.)	2	2	—	—	—	—	—	—	300	—	—	—
Vietnam (South)	—	—	—	—	—	—	—	—	12,500	+ 7	—	—
TOTAL FAR EAST	100	571	550,256	+ 7	278,369	51	1,435,154	1,230,461	1,182,683	+ 20	10,155	29,703
TOTAL FREE WORLD	3032	54,632	18,576,635	+ 7	44,204,100	628	21,803,199	18,030,744	16,660,773	+ 6	266,985	447,011
USSR & SATELLITES[e]												
Albania	16	—	12,500	+ 25	1,000	6	7,200	6,500	5,900	+ 11	18	—
Bulgaria	6	—	4,000	— 2	—	—	2,500	1,600	13,900	+ 6	5	—
China (Red)	60	—	71,500	+ 30	—	—	50,000	49,000	115,000	+ 40	2,000	—
Czechoslovakia	12	—	2,600	+ 11	43,000	—	44,000	42,000	35,500	+ 8	9	300
Germany (East)	3	—	100	—	300	5	38,000	31,700	29,000	— 2	—	—
Hungary	40	—	22,500	+ 11	13,000	5	48,000	43,500	36,500	+ 2	175	—
Korea (North)	2	—	—	—	—	—	—	—	5,000	—	—	—
Mongolia	—	—	—	—	—	1	600	550	2,400	+ 2	—	—
Poland	8	—	4,000	+ 11	40,000	5	18,000	16,500	40,000	+ 5	24	200
Rumania	54	—	220,000	+ 1	812,000	16	245,000	235,000	128,000	+ 2	1,000	—
Sakhalin	4	—	18,000	— 2	—	—	—	—	3,000	—	20	—
USSR	400	—	2,960,000	+ 14	4,547,000	90	2,550,000	2,345,000	2,400,000	+ 13	55,000	76,600
Vietnam (North)	—	—	—	—	—	—	—	—	7,000	+ 1	—	—
TOTAL USSR, etc.[e]	705	—	3,315,200	+ 13	5,456,300	128	3,003,300	2,771,350	2,821,200	+ 13	68,251	77,100
TOTAL WORLD	3737	60,000[e]	21,892,835	+ 7	49,660,400	756	24,806,499	20,802,094	20,802,094[3]	+ 7	305,426	524,111



❶ "This method of plugging a line and bypassing the flow has been used extensively in plant and field operations with WMSon tapping and STOPPLE equipment. Many costly shutdowns have been avoided. Now, WMSon engineers have re-designed and improved the STOPPLE Plugging Machine. Result . . . the all new STOPPLE II . . . offering hydraulic operation, improved, simplified construction, and economy—real economy!"



❸ "Here's how STOPPLE II works. After the tap is made, the STOPPLE II is mounted on a WMSon SANDWICH Tapping Valve, and the plugging head is lowered into the line, stopping the flow completely. New single link construction of the plugging head offers built-in simplicity . . . and strength for high pressure plugging."

NEWS FROM DOWN THE LINE!

NEW economy
NEW improved design
NEW interchangeable plugging heads . . .

WMSON'S ALL NEW STOPPLE® II

Plugging Machine for piping modification or repair WITHOUT SHUTDOWN!

❷ "Here's the major reason for this economy. The STOPPLE II has a hydraulic cylinder that is interchangeable with plugging heads of different sizes. For example, one hydraulic cylinder can be used on a 14", 16", 18" or 20" line by using it in combination with a plugging head and housing of the proper size."

•

WMSon STOPPLE II with hydraulic operation is available in sizes 8"–30". The 4" and 6" units are hand operated. Single link is standard in all sizes. Write for additional information and specifications: Write Dept. B for Bulletin A-513.

U.S. AND FOREIGN PATENTS AND PATENTS PENDING

T.D. Williamson, Inc.

P. O. BOX 40 • TULSA 2, OKLAHOMA

REPRESENTATIVES AROUND THE WORLD

another
TRETOLITE SERVICE
report

Many refiners are cutting costs . . . improving marketability with Tretolite Company products

TRET-O-LITE* *Demulsifiers*

TRET-O-LITE demulsifying chemicals were developed and pioneered to enable producers to reclaim profitably otherwise unmarketable emulsified crudes. Refiners also use TRET-O-LITE emulsion-breakers to salvage usable oil trapped in "tank-bottoms", thereby gaining valuable storage capacity lost when tank-bottoms accumulate. TRET-O-LITE demulsifying chemicals are effectively used to reclaim usable oils from refinery waste disposal systems and separator traps.

If oil and water emulsification is causing an operating problem in your refinery, call Tretolite.

TRET-O-LITE* *Desalting Chemicals*

The Tretolite Company pioneered the use of chemicals in crude oil desalting, and developed the first desalting system in which chemicals provided emulsion destabilizing action.

Refiners all over the world now rely on TRET-O-LITE for efficient, economical desalting performance.

TRET-O-LITE Desalting Chemicals also are widely used in chemical-electric desalting, as well as chemical aid to electric desalting when certain adverse treating conditions are encountered.

Ask your Tretolite Refinery Service Engineer about the economy of TRET-O-LITE *Desalting Chemicals.*

KONTOL* *Corrosion Inhibitors*

KONTOL Corrosion Inhibitors are liquid organic semi-polar compounds available in a variety of formulas. They adsorb at metal surfaces to form an impervious corrosion-inhibiting film. KONTOL Corrosion Inhibitors prevent corrosion in refinery equipment by protecting against attack by chlorides, sulfides, organic acids and hydrogen blistering. They are effective detergents and provide an economical means for maintaining cleanliness and heat transfer efficiency in condensers and exchangers.

KONTOL *Corrosion Inhibitors have been cutting maintenance costs for refiners for many years. Complete information is yours on request.*

TOLAD* *Fuel Additives*

TOLAD Fuel Additives are ashless, totally oil-soluble compounds. They stabilize color in heating oils and diesel fuels. They effectively disperse the insoluble solids which form sludge and impair burning qualities.

TOLAD additives have excellent water tolerance characteristics which prevent loss to water bottoms in fuel storage. They are available as inhibitor or inhibitor-dispersant formulations. TOLAD is approved, and used, by leading railroads.

Get all the facts on this new Tretolite product. In test after test, TOLAD *has provided better fuel stability at lower cost. Why not prove this to your own satisfaction—and profit.*

For complete information on these, or any Tretolite Company product or service, ask the Man in the Red Car, or write

*Registered trademark of Petrolite Corporation

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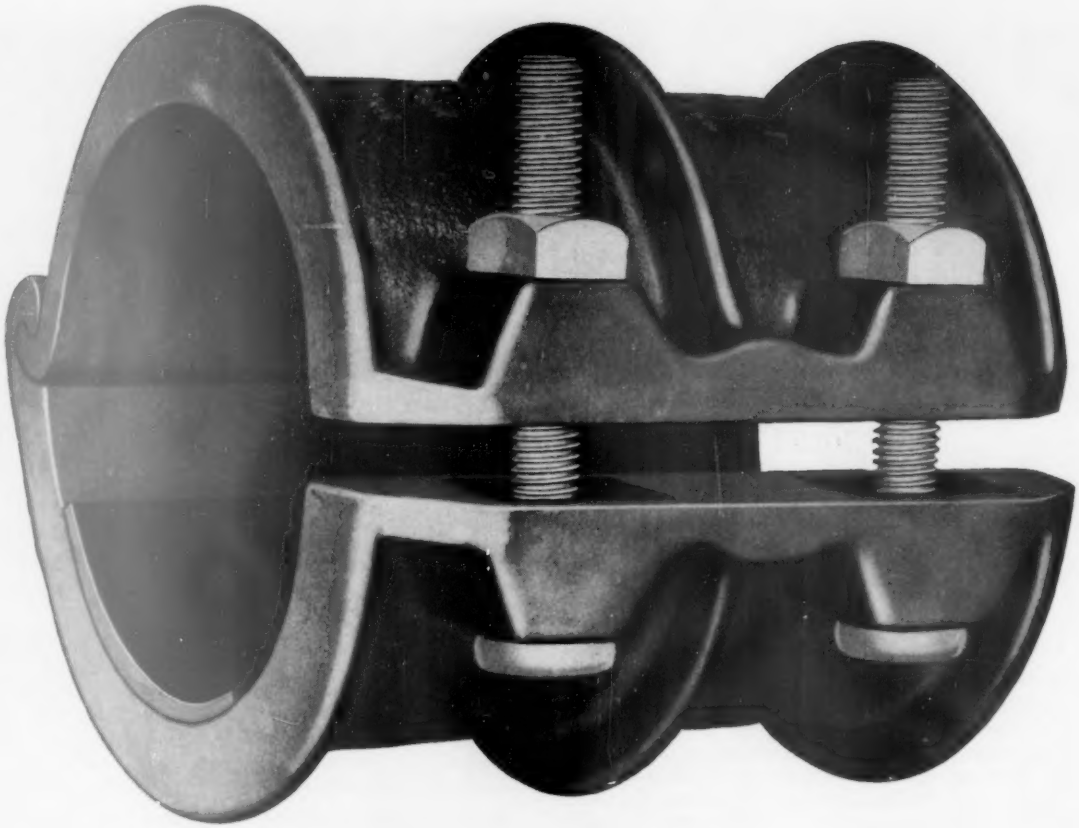

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PIPE LINE CLAMP

For repairing corrosion leaks or splits in pipe lines! Massively proportioned of malleable iron. Used on high-pressure work for over 50 years. Sizes ½" to 12" inclusive, for steel and also cast iron pipe. Stocked by most supply stores.

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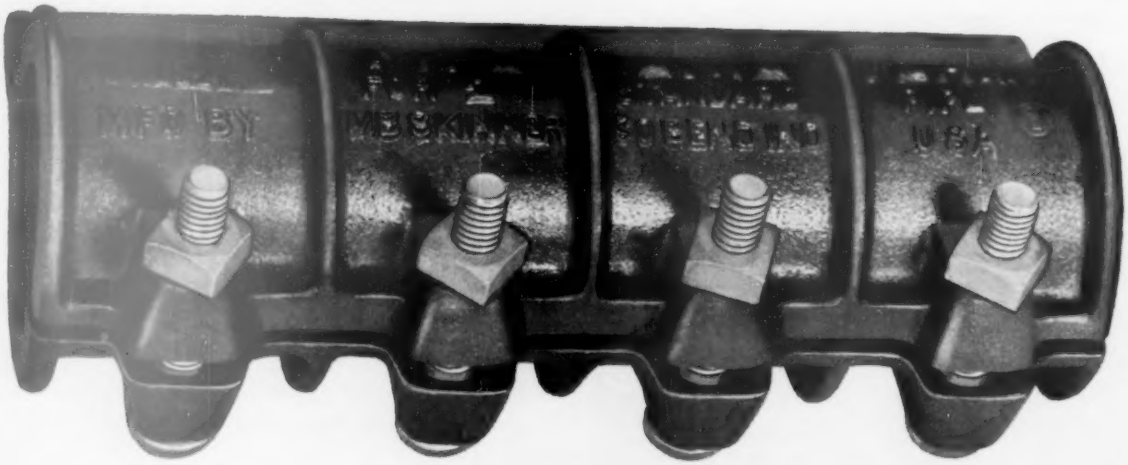

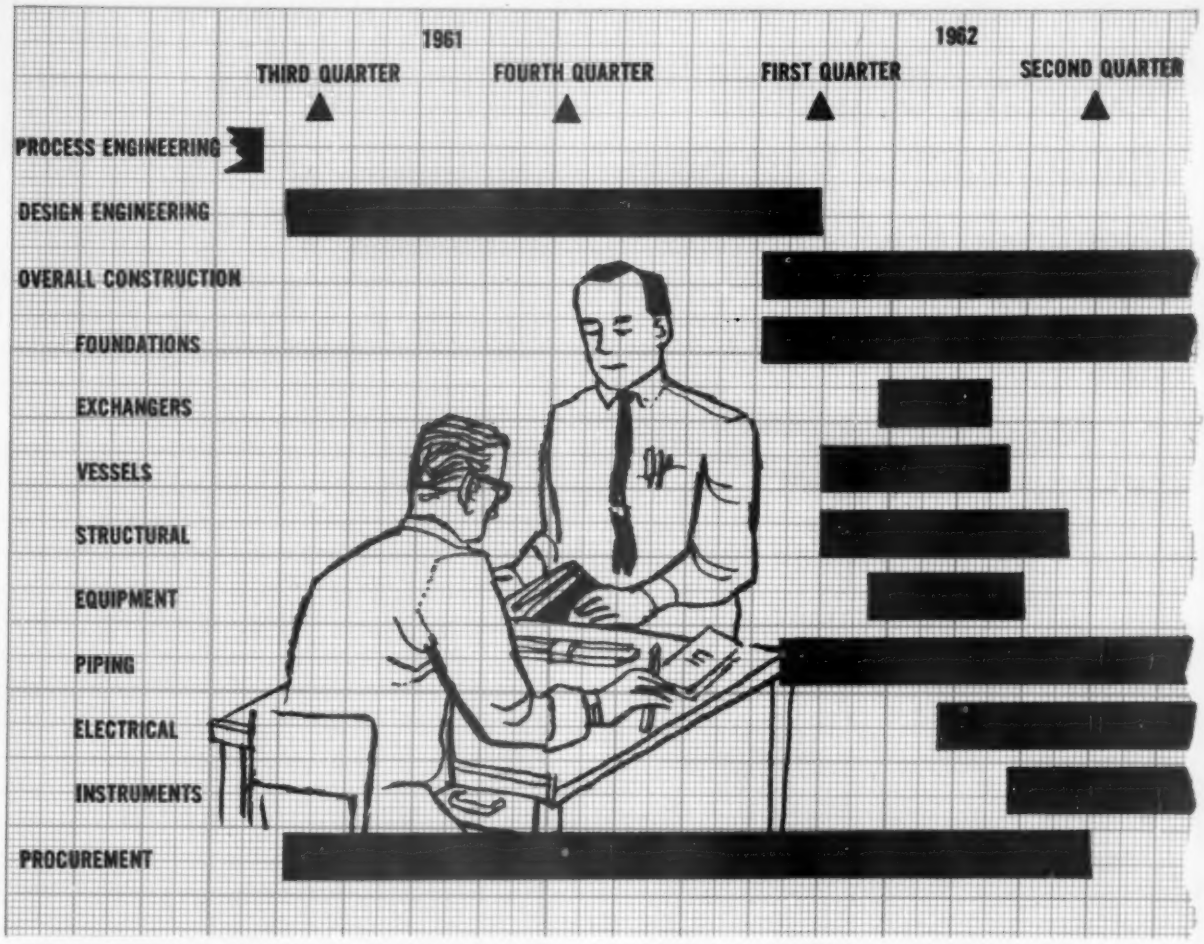

Progress Continues at Kellogg on Monsanto's New Phenol-from-Cumene Plant

The largest phenol-from-cumene plant in the United States is now in the mechanical engineering stage at Kellogg's New York Offices. Designed to produce 75 million pounds per year of high purity phenol, plus large quantities of acetone, the plant will be built at Chocolate Bayou, Texas, for Monsanto Chemical Company.

Full responsibility for engineering, procurement, and construction has been assigned to The M. W. Kellogg Company. A major portion of the process design is based on information licensed from Hercules Powder Company.

Feeds to the cumene section will be benzene and propylene; both will be produced by Monsanto at Chocolate Bayou. Feeds to the phenol section will be cumene and air. The entire project, part of the huge multi-million-dollar chemical complex Monsanto is building at Chocolate Bayou, is scheduled for completion in the summer of 1962.

Kellogg-Monsanto teamwork at Chocolate Bayou is another example of Kellogg's active participation in helping chemical, petrochemical and refining companies achieve their broad investment goals. To obtain information on how the Kellogg organization can translate your new-plant investment into the finished plant, you are cordially invited to contact The M. W. Kellogg Company.

THE M. W. KELLOGG COMPANY

711 Third Ave., New York 17. *A subsidiary of Pullman Incorporated*

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Kellogg International Corporation, London
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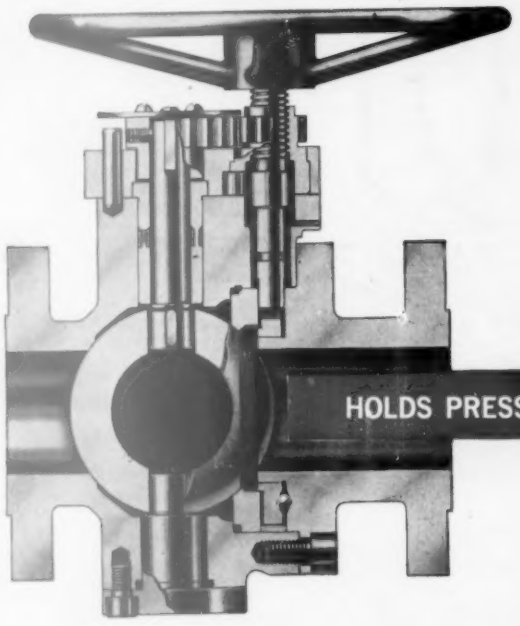

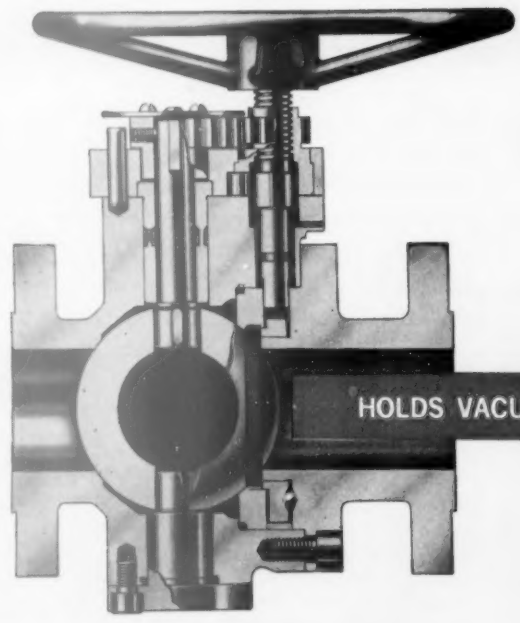

HYDRIL

BALL PLUG Type "K"

VALVES

Controlled sealing . . . a new concept in valve design . . . is the secret of Hydril's tight, bubble-proof shutoff. Hydril Ball-Plug Valves always seal positively against pressure from either direction—or against vacuum—because the fully confined packing ring is mechanically compressed between plug and seat when the valve is closed. This tightly compressed gasket type seal easily bridges clearances between parts as well as surface imperfections. Result: seal efficiency is unimpaired by prolonged hard usage, by rust or sediment.

Design of Hydril Type "K" Ball Plug Valves assures minimum maintenance costs. Non-lubricated, they employ no sealing lubricants. There's no sliding friction between plug and body to produce wear and abrasion.

The spherical plug is mounted on accurately positioned bearings, maintaining a minimal controlled clearance between plug and body. This contributes to easy, free-turning operation as well as to long service life.

●

Hydril valves are available in a wide range of sizes and ratings. Worm-gear and motor-operated models can be supplied. Get the full story on Hydril Valves from your nearby representative . . . or write Hydril Company for free Catalog No. V-60.

HYDRIL COMPANY

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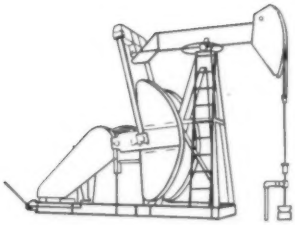
When you buy a Cabot Pumping Unit you buy more than the unit itself. You're buying *fast, courteous service* for that unit day or night . . . 365 days a year! Cabot maintains convenient service centers throughout the oil country, each having a complete stock of Cabot Pumping Unit parts and staff of factory trained personnel. If you are not now using Cabot units . . . make your next one a Cabot! You'll prove to yourself that *Cabot Quality* plus *Cabot Service* adds up to the tops in dependable pumping.



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OIL FIELD PUMPING EQUIPMENT
CABOT
PAMPA, TEXAS
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CABOT CORPORATION
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Here's the answer for a truly efficient, all-purpose bridge plug — one so simply constructed, with no moving parts, that it will not fail mechanically — so positive in sealing action that you get a leak-proof seal under hydrostatic pressures as high as 13,000 psi — yet so versatile it will successfully accomplish the most difficult plugging operations as well as the easiest.

The McCullough Bridge Plug is an explosive-expansion plug made of drillable aluminum. It is set at the desired location by the power of expanding gases from within the plug. On permanent installations it will last as long as the pipe in which it is set. It is ideal for temporary plugging operations as it drills out quickly and easily with a rotary bit.

TAKE A LOOK AT THESE FEATURES

- Simple, one-piece, all-aluminum construction. Slips, reins, rubber packers and all hardened or moving parts that might impede drilling out have been eliminated.
- No slips to hang up or accidentally trip and set the plug while going in the hole.
- Makes a positive leak-proof seal under the heaviest hydrostatic or mechanical loads.
- Easier on the pipe than a slip-type plug.
- Because it's shorter and smaller in diameter it easily passes through tight spots, dog legs, etc., and saves rig time in running, locating and setting.
- Drills out easier and faster.
- Resists corrosion and electrolysis.
- Available in 37 sizes from 1¾" OD to 10¾" OD for tubing, drill pipe, casing and in open hole in hard formations.

FOUR BOWEN POWER SWIVELS

JOB-MATCHED TO CUT ROTARY COSTS

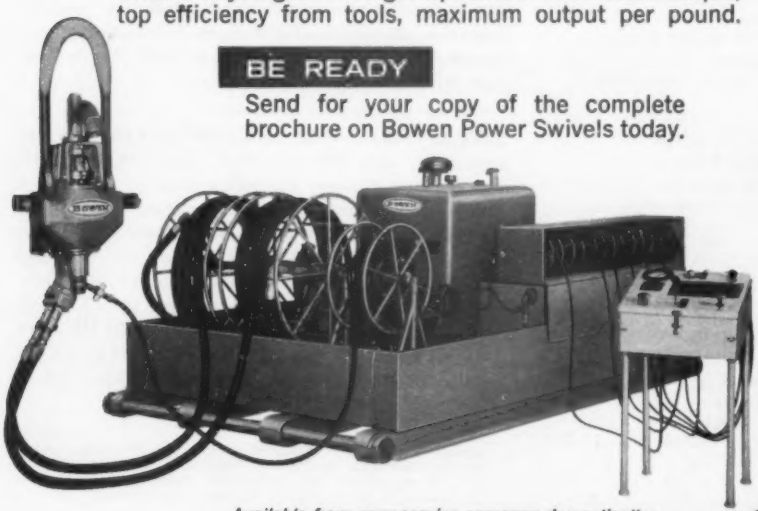
Now—for the first time—you can get exactly the Hydraulic Power Swivel you need to fit any job . . . no waste power . . . no overload .

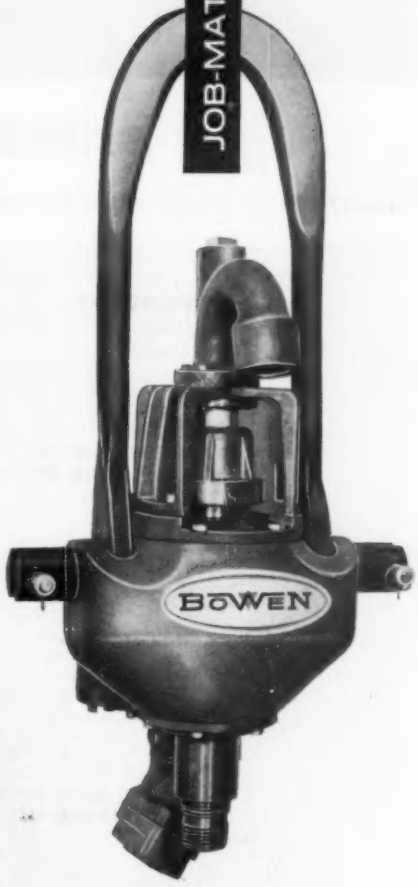
Bowen Power Swivels are available in four basic models . . . A.P.I. static load ratings to 15 - 25 - 40 - 65 tons . . . maximum stem torque ratings of 2,000 - 1,500 - 3,000 - 6,000 ft./lbs. Engines are power-matched to swivel requirements. Unitized for quick installation, easy moving, minimum maintenance—mounted on skids, trailer or truck, at your option.

With Bowen Power Swivels, you eliminate . . . expensive rotary rigs, unneeded power, needless bulk, complex rigging. You save . . . rig-up time, moving time, operating time. And you get . . . finger-tip control . . . instant torque, top efficiency from tools, maximum output per pound.

BE READY

Send for your copy of the complete brochure on Bowen Power Swivels today.





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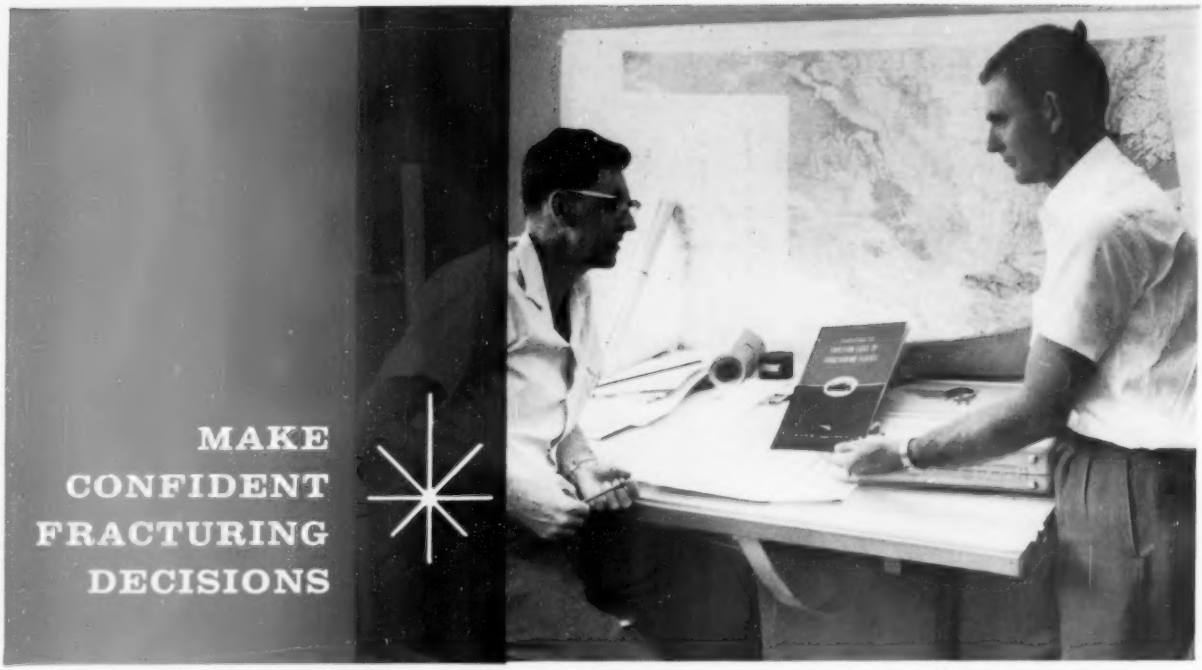

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Begin programming your next fracturing treatment by calling in a Halliburton man. He will supply sound, seasoned advice to assist you in making profit-wise decisions.

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Things To Come

USSR OIL EXPORTS

Over the next four or five years, export of Soviet oil to non-communist bloc nations of the world will double, predicted Interior Secretary Stewart Udall at an Eastern District API meeting. Current USSR oil exports, Udall reported, exceeds 500,000 bbl per day to non-communist bloc countries.

APPALACHIAN FUTURE

The next 18 to 24 months may decide the oil and gas future of the Appalachian region, says Dr. Herbert Woodward, Dean, Rutgers University and geological expert. Eyes of both major and independent firms are on this promising basin that appears on the threshold of renewed activity. More acreage is under lease than ever before... the search goes deeper as rig count pushes upward. A significant discovery could set off a boom.

PRODUCTION OUTLOOK

September and October will see U.S. production average 6.9 million bbl daily, according to a recent IPAA Supply & Demand Outlook report. This compares with about 7.0 million bbl per day last July and an average of 6.957 million bbl daily during August-October 1960. Total petroleum demand for September-October this year is expected to average out at 9.4 million bbl daily... a 2% increase over same period last year.

FPC TOUGHER ON GAS

New makeup of the Federal Power Commission means tougher going for both transmission companies and gas producers. Joseph C. Swidler, new liberal FPC chairman and devoutly consumer-minded, is outspoken on what he thinks the role of FPC should be. He proposes a full investigation into financial structures and operations of any company seeking rate increases. Howard Morgan, another New Frontier appointee, is expected to back up this stand. Lawrence O'Conner, with some previous experience in petroleum, is also a Democrat. Jerome K. Kuykendall, former Eisenhower appointee, yielded chairmanship September 1, but may not fulfill his term which ends next June. Remaining member was Frederick Stueck, recently deceased.

BAROID OIL MUD SOLVES WATER-

Baroid Field Report: Los Angeles County, California This case history exemplifies the application of one

MUD PROBLEM:
To drill and complete in water-sensitive pay sands

WELL DATA

LOCATION: Inglewood Field, Los Angeles County, California
TOTAL DEPTH: 9,390'
BOTTOM HOLE TEMPERATURE: 275 F to 300 F

CASING PROGRAM

SIZE, INCHES O.D.	DEPTH SET, FEET
16"	550'
10¾"	3,000'
7"	8,975'

MUD ADDITIVE PROGRAM

550 to 3,000'	AQUAGEL*—caustic soda—CARBONOX* emulsion mud
3,000' to 7,400'	Water-base emulsion mud containing 10 volume percent oil, HYDROCARB* and TRIMULSO*
7,400'	Displaced the oil-in-water-emulsion mud with Baroid Oil Mud
7,400' to 9,390'	Drilled with Baroid Oil Mud containing INVERMUL*, PETROTONE** and DURATONE**

TYPICAL MUD PROPERTIES OF BAROID OIL MUD

Depth, ft.	7,414	8,150	9,390
Weight, lb/gal	10.8	11.6	12.2
Viscosity, sec	95	115	131
Filtrate, ml (oil)	0.0	0.0	0.5
Oil, % by volume	45	44	42
Solids, % by volume	15	21	22
Water, % by volume	40	35	36
Electric Stability, volts	220	230	220

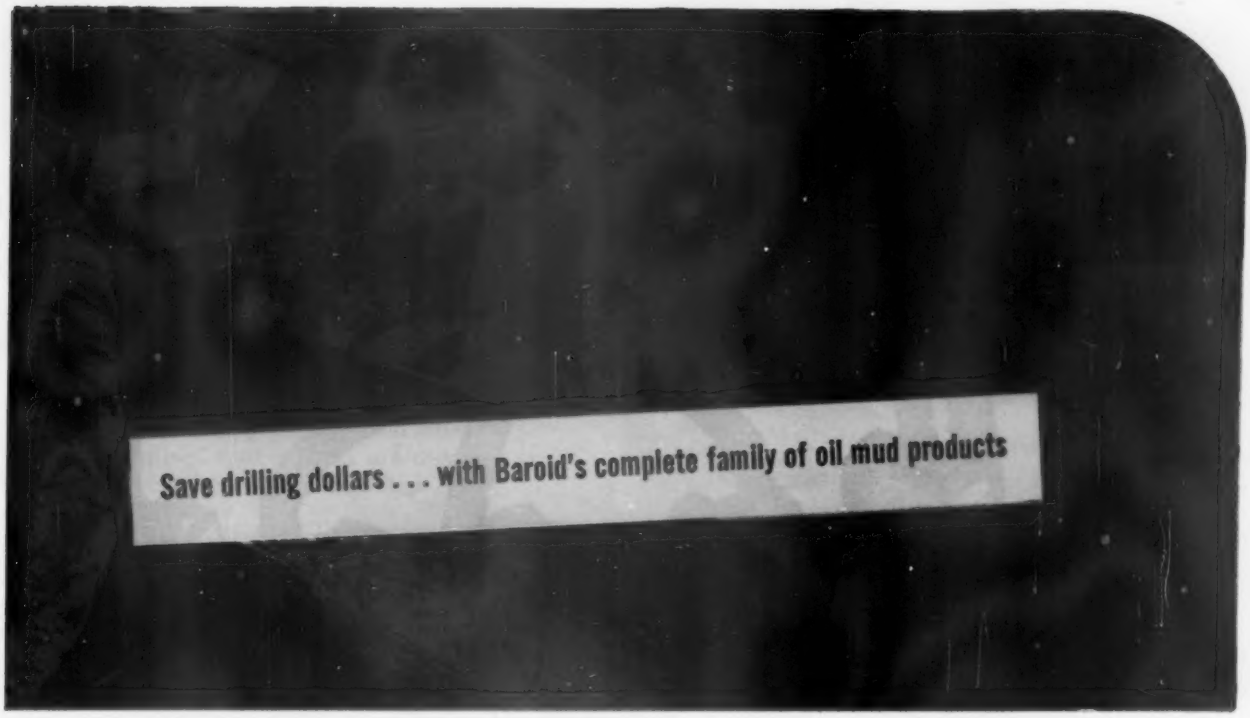
DISCUSSION: Water-sensitive formations and high bottom-hole temperatures below 7,500 feet in the Inglewood Field, Los Angeles County, California present a problem in the selection of a drilling mud. Formation damage is attributed to the filtrate from conventional water muds. To prevent formation damage and minimize hole enlargement Baroid Oil Mud was selected to drill the bottom 2000 feet of hole.

SOLUTION: The Baroid Oil Mud selected was pre-mixed with INVERMUL and DURATONE and used to displace the water mud at a depth of 7,400'. No difficulty was encountered during the displacement. Water mud incorporated into the INVERMUL-DURATONE Oil Mud did not alter its flow properties. To prevent settling of BAROID* as bottom-hole temperature increased (275 F to 300 F), the oil mud was treated with 2 lb/bbl PETROTONE. Filtration was maintained at 0.0 to 0.5 ml. all-oil, eliminating any possibility of water-wetting the formations.

*AQUAGEL, bentonite; CARBONOX, thinner; HYDROCARB, alkaline thinner; TRIMULSO, surfactant; INVERMUL, emulsifier; DRILOIL, oil mud concentrate; and DRILTREAT, stabilizer; are Registered Trademarks of Baroid Division National Lead Company.

**PETROTONE, suspending agent, and DURATONE, filtration stabilizer, are Trademarks of Baroid Division National Lead Company.

BAROID—*Still Pioneering Drilling Mud Research • Engineering • Marketing*



SENSITIVE PAY SAND PROBLEM

type of Baroid Oil Mud used to solve this particular problem.

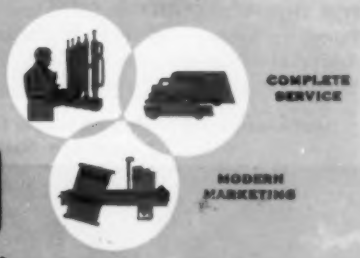
The Baroid family of oil mud products are INVERMUL, DURATONE, PETROTONE, DRILOIL® and DRILTREAT®. These products allow the operator to select an oil mud having properties suitable for the drilling problem. Such properties can also be modified by treatment if necessary. This approach has long been used in the selection and treatment of conventional drilling muds but is new to oil muds. This new approach to oil muds has resulted in their successful use for drilling, coring, completion, perforating, gravel packing, packer fluids, freeing stuck drill pipe, and for fishing.

In this case history in Los Angeles County, California, a Baroid Oil Mud was selected as the practical solution to the problem of drilling and successfully completing water-sensitive pay sands. At 7,400 feet an INVERMUL-DURATONE Oil Mud was used to displace the damaging water mud. This oil mud was treated with 2 lb/bbl PETROTONE to eliminate any possibility of settling of weight material as bottom-hole temperature increased. Drilling was trouble-free and completion successful.

INVERMUL, a free-flowing powder, the basic ingredient in this Baroid Oil Mud is an active, readily oil-dispersible emulsifier that stabilizes the emulsion and protects productive formations by controlling filtration.

PETROTONE is a dry powdered colloid that imparts solids-suspending properties to all types of oil muds — is easily mixed — treatment is nominal in cost. The usual amount added is 1 to 5 lb/bbl of oil mud. PETROTONE is stable at the highest bottom-hole temperatures presently encountered in drilling.

DURATONE, a unique organic colloid, controls filtration of all types of oil muds at the highest bottom-hole temperatures. The development of DURATONE and PETROTONE, as companion products to INVERMUL, has diversified and extended the application of oil muds. This is another example of how Baroid's customer-oriented program of research and engineering saves you drilling and completion dollars and keeps your operations on schedule.



BAROID

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MORE BBLs/DAY WITH oilmaster CAVITY BALANCED HYDRAULIC FREE PUMP

Perhaps you were one we surveyed when our pollsters returned a unanimous verdict... **Develop a hydraulic unit that will get more barrels/day with smaller production tubing.**

We've even surprised ourselves. We could write a book or talk for a week about this **volume thirsty hydraulic pump,** but we think the following condensed specifications will tell quite a bit. Would you like to hear more?

FOR THE FULL STORY on Oilmaster Hydraulic Pumping Systems write Fluid Packed Pump, Armco Steel Corporation, 9100 South Norwalk Boulevard, Los Nietos, California.

Tubing Size API	Unit Assembly Number	Bore		Bal. Press PSI per 1000'	Rated Speed	Stroke Length	Bbl/day Capacity at Rated Speed	
		Engine	Pump				Engine	Pump
2⅛"	FB171313	1.300	1.300	433	64	22	268	268
2⅜"	FEB201616	1.600	1.600	433	55	32	517	517
2⅞"	FEB252020	2.000	2.000	433	50	36	825	825
3½"	FEB302424	2.400	2.400	433	42	48	1350	1350

Designed especially for use in casing free installations. Where gas is a problem and casing size permits, an independently landed gas vent string can be used to vent gas from under the packer.

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ARMCO Fluid Packed Pump

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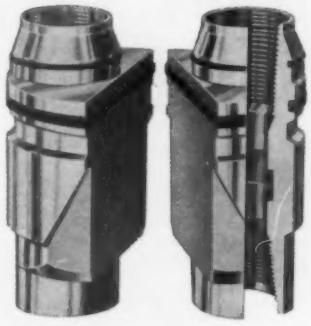
From start to finish RECTOR Multi-String Tubing Heads allow full passage of packers and other tools to the oil string. Split hangers are automatically aligned in the head by fixed lugs . . . no guide pin necessary.

Tubing strings are run and landed without removal of blow-out preventers. Positive control of well is maintained by sealing elements on hangers and removable RECTOR-PSI circulating full opening back pressure valves during removal of blow-out preventers and installation of Christmas Tree. A special Rector multi-seal ring on each hanger insures positive steel seal for each tubing string.

Available through your favorite supply store or your Rector representative.



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Making the Oil Industry Safer!

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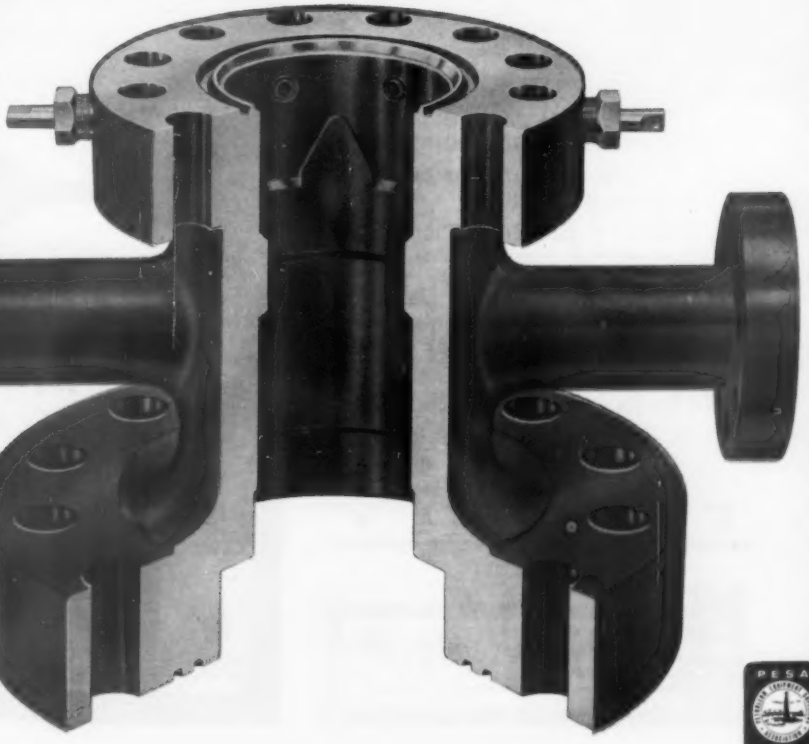

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Trinity
LITE-WATE

A Complete Low Density Cement with

EXCEPTIONAL COMPRESSIVE STRENGTH

Strength is recognized as one of the important qualities of an oil well cement slurry. TRINITY LITE-WATE cement develops exceptional compressive strengths.

In the range of lightweight cement slurries, TRINITY LITE-WATE produces a slurry which is:

1. Light enough to circulate.
2. Strong enough for any casing seat.
3. Strong enough to permit hydraulic fracturing.
4. Impervious to migrating fluids.
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For TRINITY LITE-WATE cement call your service company.

For complete Laboratory Data call your local Trinity Representative or write Dallas Office, P. O. Box 2698 or phone RIverside 2-8111.

376 lb. Barrel 94 lb. Sack
75 lb. Dry Volume per cubic foot

SALT
12¼ LB. SLURRY LITE ENOUGH TO CIRCULATE ANY STRING
13½ LB. SLURRY STRONG ENOUGH FOR ANY CASING SEAT
TRINITY DIVISION
TRINITY
TRINITY HIGH EARLY STRENGTH PORTLAND CEMENT

TRINITY

PORTLAND CEMENT DIVISION
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Mission rods are here to stay

because Mission Super-Chrome rods have 2 wearing surfaces

Ordinary rods must fight corrosion fatigue as well as the fatigue from tensile and compressive stresses. But, the tough, hard-chrome plating you see in the photograph protects Mission Super-Chrome® rods against corrosion fatigue. That's one more reason Mission rods last longer. Beneath the coat of heavy chrome you can see the deep, file-hard case. Inside is the tough, high strength core. Its unusually high ductility will resist the fatigue induced by literally millions of tension and compression cycles, while the chrome plating resists the corrosion fatigue which could be induced by millions of gallons of drilling fluid. Mission Super-Chrome rods are sure to stay in your pump longer than any others. Specify Mission parts all the way and save all the way.

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*Type **H** Hydraulic*

WIRE LINE OIL SAVER

Hydraulically operated, Guiberson's Type H Wire Line Oil Saver is controlled remotely by applying or releasing hydraulic pressure through a 50′ hose from pump to saver. The Type H effectively and uniformly cleans the wire line. This keeps the working area and equipment free of well fluids, reducing the hazards of fire and accident. Comply with Guiberson's slogan, "Better Be Safe Than Sorry," by using the Type H. There is no need for a man on the monkey-board during swabbing and redressing operations, which should please your insurance company.

Advantages of Type H Saver:

Hydraulically operated by field-proved piston principle . . no trouble-causing rubber bladders or complicated mechanism.

Large rubber and generous bushings give a smooth, constant seal. Rubber can be used until almost completely consumed.

Ram has 2½" hydraulic stroke with spring-actuated return.

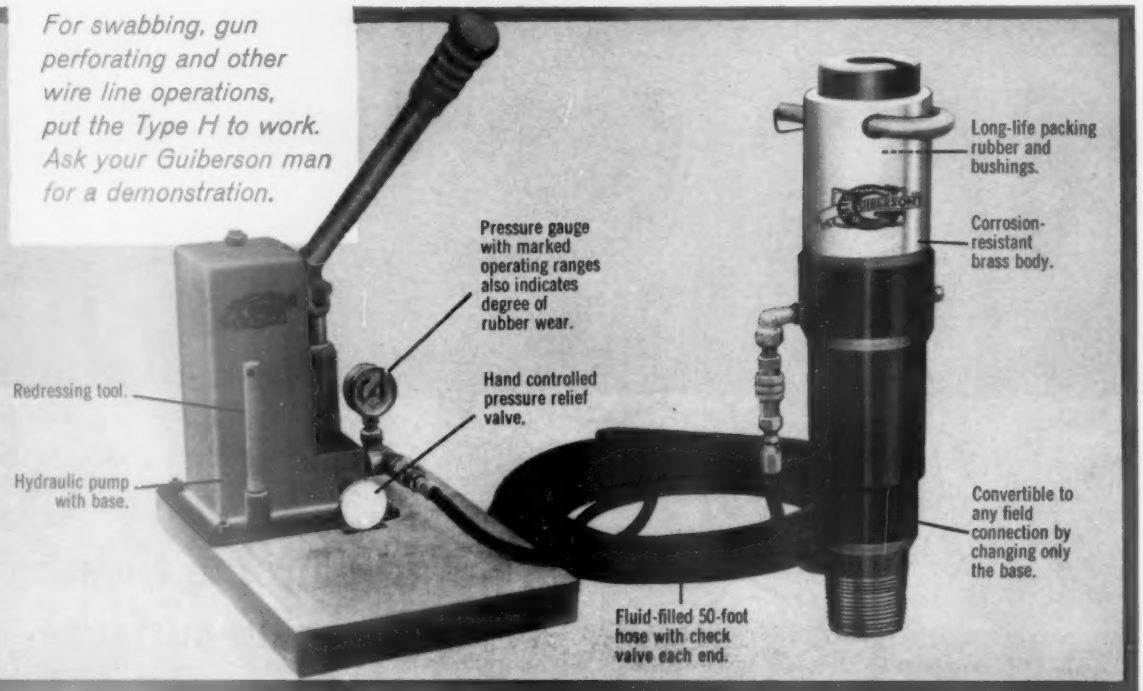
Non-sparking, durable split bushings . . top and bottom interchangeable.

Saver is quickly and economically redressed at top of unit . . no threaded connections.

Bushings and rubbers for ⅜" to ⅝" or ¾" to 1" line.

Remotely controlled . . allows at least 50′ leeway from saver to pump.

For swabbing, gun perforating and other wire line operations, put the Type H to work. Ask your Guiberson man for a demonstration.


Long-life packing rubber and bushings.
Corrosion-resistant brass body.
Pressure gauge with marked operating ranges also indicates degree of rubber wear.
Redressing tool.
Hand controlled pressure relief valve.
Hydraulic pump with base.
Convertible to any field connection by changing only the base.
Fluid-filled 50-foot hose with check valve each end.

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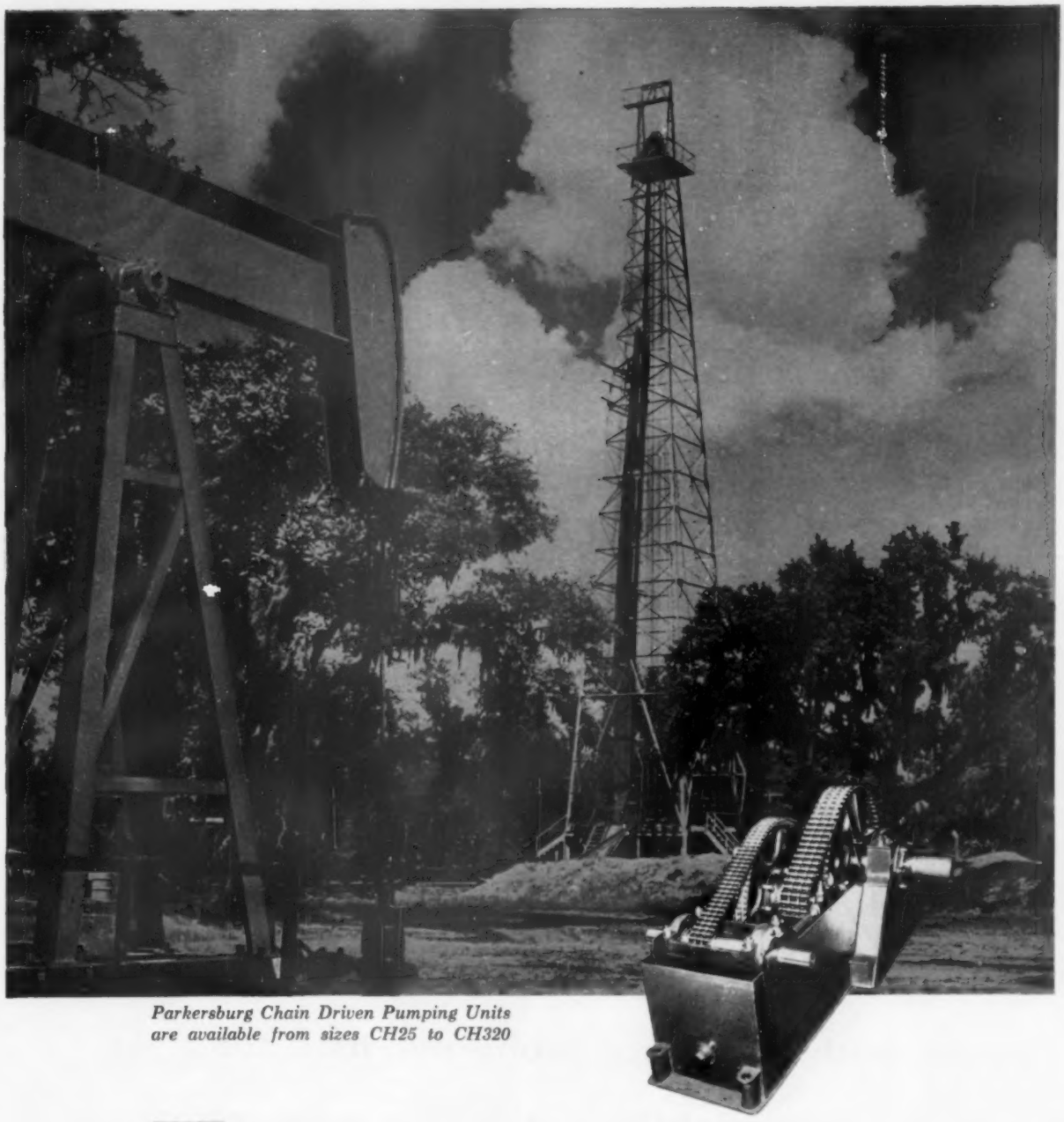

Parkersburg Chain Driven Pumping Units are available from sizes CH25 to CH320

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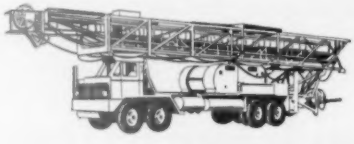

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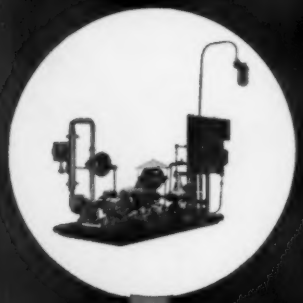

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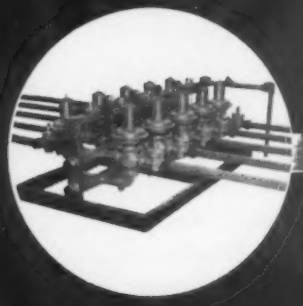

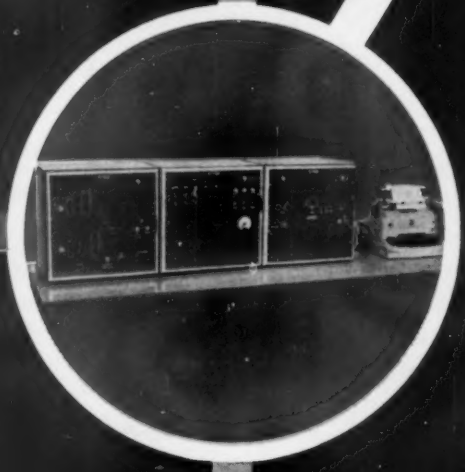

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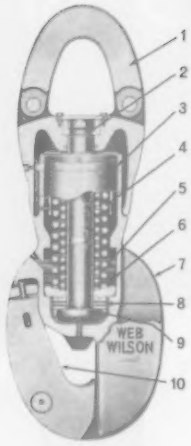
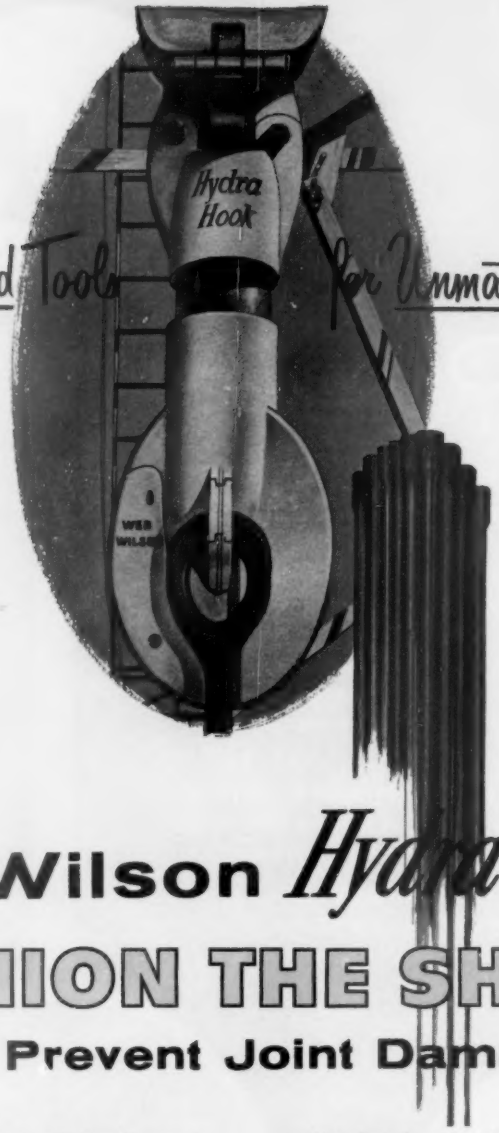
"Matched Tools for Unmatched Performance"





Web Wilson *Hydra Hooks*

CUSHION THE SHOCK

to Prevent Joint Damage

Every time a joint is made up or broken out, you benefit from the simple, foolproof shock absorbing hydraulic action of the Web Wilson Hydra Hook that prevents damage to threads and shoulders. Another distinct advantage—Hydra Hook is the shortest on the market—the least expensive way to add feet and inches of working height.

Economical operation and simple servicing are assured by these features: (1) Can be unitized or direct connected to all leading traveling blocks • (2) No load carrying threads—solid shank carries load • (3) 8 locked positions (12 in 450 ton) prevent rotation • (4) Less than 10 working parts • (5) Transported without draining oil • (6) Major internal parts enclosed in oil bath • (7) Parts are magnaflux inspected • (8) Large, staggered roller bearing, in oil bath for free swiveling • (9) No seals in hydraulic reservoir to leak • (10) Latch *cannot* open with load applied.

The WW Hydra Hook is another of the tools in the Baash-Ross line of "*Matched* Tools for *Unmatched* Performance" to speed operations at reduced expense.

See a Baash-Ross representative or the Composite Catalog for additional details.

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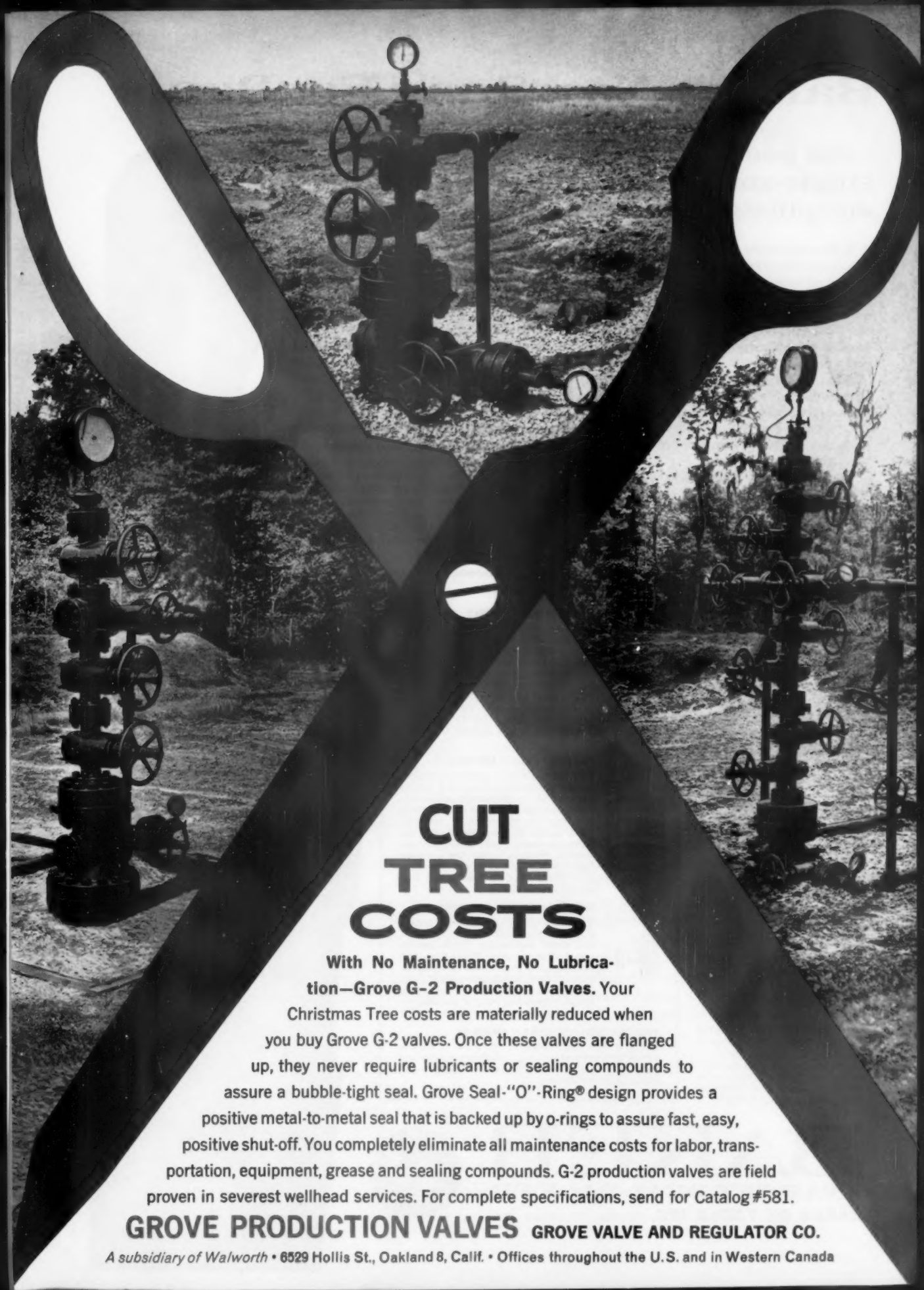

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With No Maintenance, No Lubrication—Grove G-2 Production Valves. Your Christmas Tree costs are materially reduced when you buy Grove G-2 valves. Once these valves are flanged up, they never require lubricants or sealing compounds to assure a bubble-tight seal. Grove Seal-"O"-Ring® design provides a positive metal-to-metal seal that is backed up by o-rings to assure fast, easy, positive shut-off. You completely eliminate all maintenance costs for labor, transportation, equipment, grease and sealing compounds. G-2 production valves are field proven in severest wellhead services. For complete specifications, send for Catalog #581.

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Baker's New Snap-Set Duals

—the packers that are bringing single-zone control and simplicity to dual completions

A Baker dual-string completion approaches the control and simplicity (and the flexibility) of a single-zone completion. What makes this possible? Mainly the development of better upper retrievable packers—Baker's new Snap-Set Dual Packers. Operators all across the country are commenting on their impressive performance.

What makes a good dual-string packer? Several things, starting with the ability to (a) set and unset readily and repeatedly; (b) pack off and retrieve easily; (c) hold a dependable packoff even when pressures and temperatures are high.

Do Baker's new dual packers do these things? They do. This is easy to understand when you consider Baker's vast experience with high performance retrievable squeeze packers. The Baker Full-Bore Cementer, for instance, has seen action in thousands of successful high pressure cementing, frac, and testing operations. This squeeze packer experience has made important contributions to the design of these new dual production packers.

That's only a brief look at the story of these remarkable packers. A few more of the interesting facts are spelled out by the pictures and text below. For a complete fill-in on Baker snap-set duals and the hookups they're used in, consult Baker's field staffs and send for literature.

FACTS ON PLANNING DUAL-STRING COMPLETIONS

Baker field staffs have all the latest facts and figures on Baker's intensive continuing study of dual-string completions. They will welcome your inquiries. We will also be glad to send you the latest literature. Please write Baker Oil Tools, Inc., P.O. Box 2274, Terminal Annex, Los Angeles 54, California.

TWO BASIC MODELS. Model J (Product 756-J) is long-string set. Model K (Product 756-K) is short-string set. Both come with or without hold-down buttons (double or single grip). The pictures show single-grip Model J.

WHAT MAKES A GOOD DUAL PACKER?

The text above tells some of the things that are important. Here are a few more of the facts, starting with big unrestricted bores. Big bores are important because they permit you to run instruments and workover tools. These are probably the largest bores it's possible to design into a dual packer. For instance, a Baker dual packer for 7" casing is full-opening for two strings of 2⅜" tubing.

POSITIVE PACKOFF AND RELEASE

This three-element packing element design achieves a positive and lasting packoff with minimum set-down weight. It also simplifies release when you want to reposition or retrieve. What makes this possible is that the design prevents packing element extrusion without using the conventional metallic back-up rings that sometimes stick to the casing and defeat retrievability.

WHY SNAP-SETTING IS IMPORTANT

This simple snap-latch is what makes a Baker dual packer so easy to set and unset repeatedly. There are no one-shot shear pins. There's no ball dropping, no pressuring, no rotation. Just set down minimum weight to set packer, and pick up to release. This simplifies spacing out and enables you to test packers before displacement.

YOU CAN DISPLACE WHILE FLANGED UP

Using a side door completion valve, or sleeve valve, or other method, you can displace mud and wash in both zones with well head flanged up and under complete control.

BAKER

SNAP-SET DUAL PACKERS

BAKER OIL TOOLS, INC. HOUSTON • LOS ANGELES • NEW YORK

by E. J. Jocquel

Engineering the Hassi Messaoud Field

The fabulous Hassi Messaoud field in the French Sahara was discovered in June 1956 and has since been constantly in the news.

Although the romantic end of the story has often overshadowed important technical details of the field's development, here is the engineering story of Hassi Messaoud from discovery to secondary recovery.

Hassi Messaoud is operated by two companies — Compagnie Francaise des Petroles (Algerie), CFP(A), and Societe Nationale des Petroles en Algerie, SN REPAL — each owning approximately half the field. Discovery well, Md 1, was drilled by SN REPAL in June 1956.

Reservoir and Productivity

Many unusual drilling and producing problems have been encountered in this field, especially in the northern part operated by CFP(A). Most have been aggravated by the Saharan desert climate, distance from Algiers (which has complicated the local supply problem) and even longer supply lines to France and the United States, major sources of specialized equipment.

In spite of these difficulties, field development has progressed very rapidly. Drilling on a large scale started in 1957 soon after the first producing well was completed in July 1956.

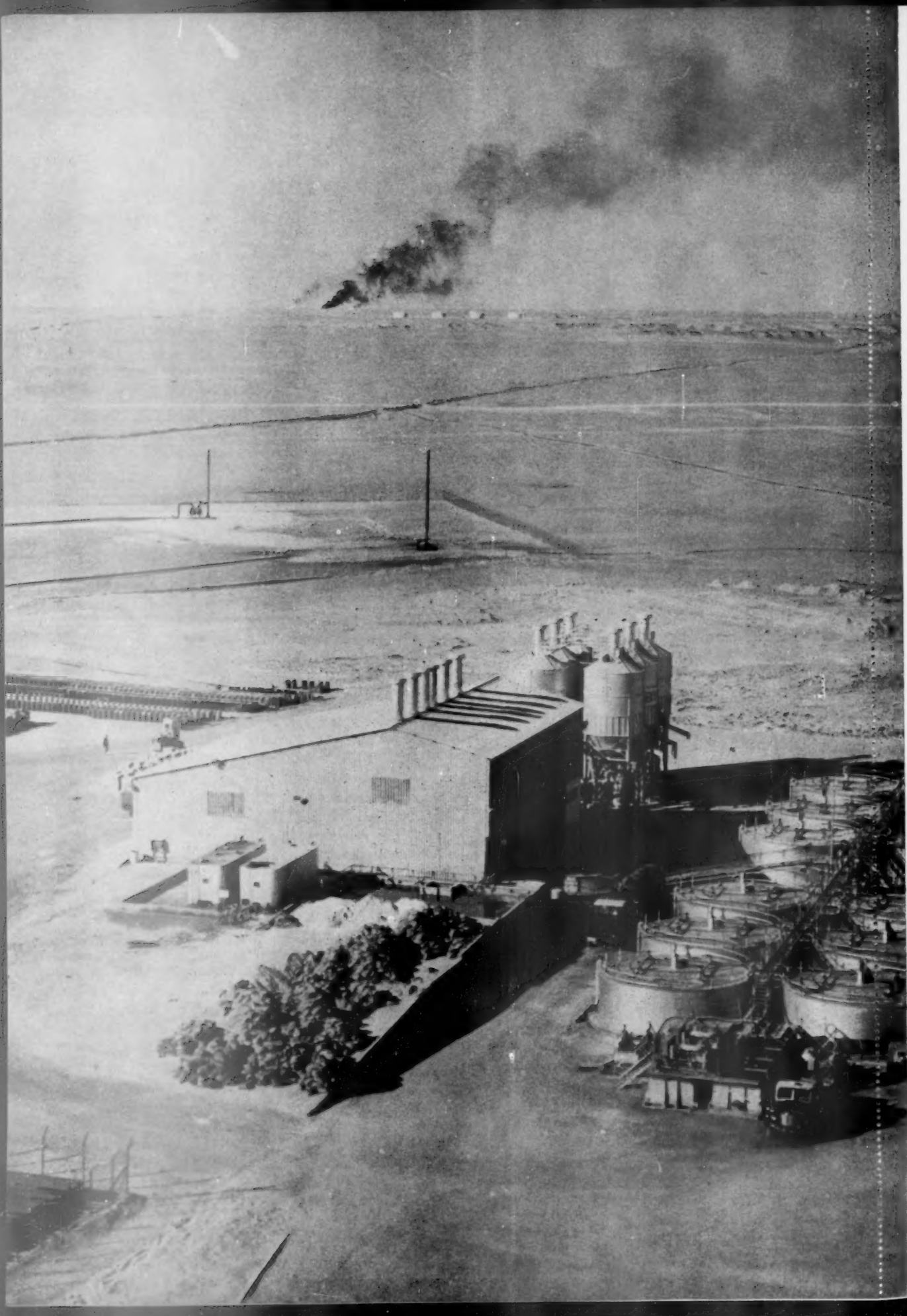
In January 1958, a small crude pipeline (6-in.) was put in service between the field and the town of Touggourt, from where crude was transported by rail to the Mediterranean port of Philippeville. This method of transporting oil ended with completion of a 24-in. pipeline from the field direct to the port of Bougie. The 24-in. pipeline was placed in service in December 1959 with a rated capacity of approximately 300,000 bbl per day.

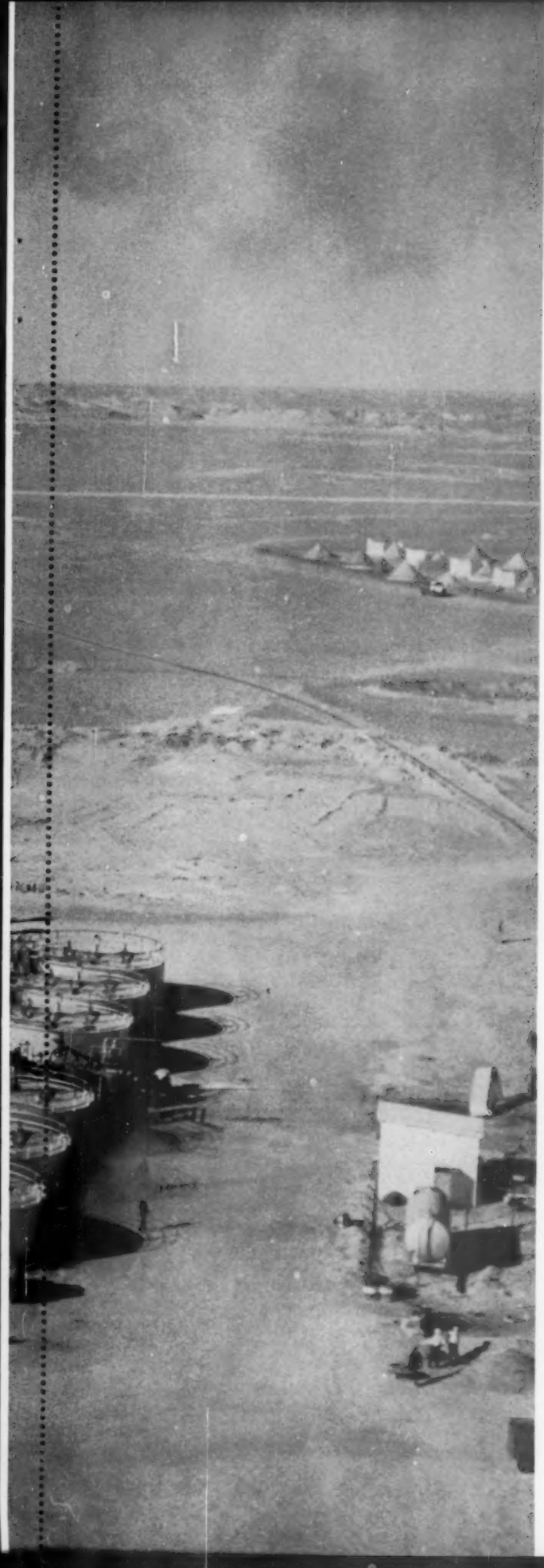
Only a little more than three years elapsed between discovery of the first well and beginning of production on a large scale. Total production as of March 1, 1961, had reached about 75,000,000 bbl. Production rate is being regularly increased to reach a scheduled rate of 172,000 bbl per day in 1961 for the entire field. In the whole field, 96 wells have been completed to date, but only 66 of them are producing normally. Well spacing with few exceptions has been about 3100 acres.

The subsurface structure of the Hassi Messaoud region, as originally determined by refraction seismograph, shows a vast, flat, anticlinal high with dips of less than ½ deg. Actual proved surface area of the central zone is nearly 400 square miles. Form of the structure has been determined by extension wells.

The reservoir, found at an average depth of 10,800 ft, is siliceous cemented quartzitic sandstone of lower Paleozoic (Cambrian) age. The Cambrian sandstones are eroded in their upper part and covered by beds of argillaceous sandstone of the Triassic. The Triassic is covered by a thick saliferous series which forms the caprock of the Hassi Messaoud field.

The Paleozoic fold has been leveled off by erosion, especially in the higher part of the structure. In addition, there is a superimposed erosion resulting from a former hydrographic network established on this surface. These





phenomena result in variations in the average physical characteristics and hence in a certain heterogeneity which gives rise to different zones of productivity.

Four Main Zones

On the basis of electrical logs and cores, four main zones have been distinguished from top to bottom:

1. The Q zone, found only in some of the wells drilled to date, is a very low permeability, fine-to-medium-grained quartzinic sandstone. Networks of fine fractures occasionally improve reservoir characteristics of this zone. Its maximum thickness on the flanks is about 260 ft.

2. The R_1 zone, which constitutes main portion of the reservoir, is a medium-grained sandstone with substantial variations in facies due to degree of silification of the rock. Porosity ranges between 8 and 10% and permeability varies widely from 1 to 1500 md as a function of the cementation factor. Thickness is 360 ft where it is not eroded.

3. The R_2 zone is divided into 2 subzones, r_1 and r_2. The upper zone, r_1, has sufficiently good physical characteristics to constitute a satisfactory reservoir (115 ft thick, 11.5% porosity, 10 md permeability). The R_2 is a medium to coarse argillaceous sandstone about 262 ft thick and it constitutes a transition between the R_1 and R_3 zones.

4. The R_3 zone, a sandstone with abundant argillaceous cement, has been penetrated by only three wells. Where found, the basement is granitic or fine red sandstones attributed to the Infra-Cambrian.

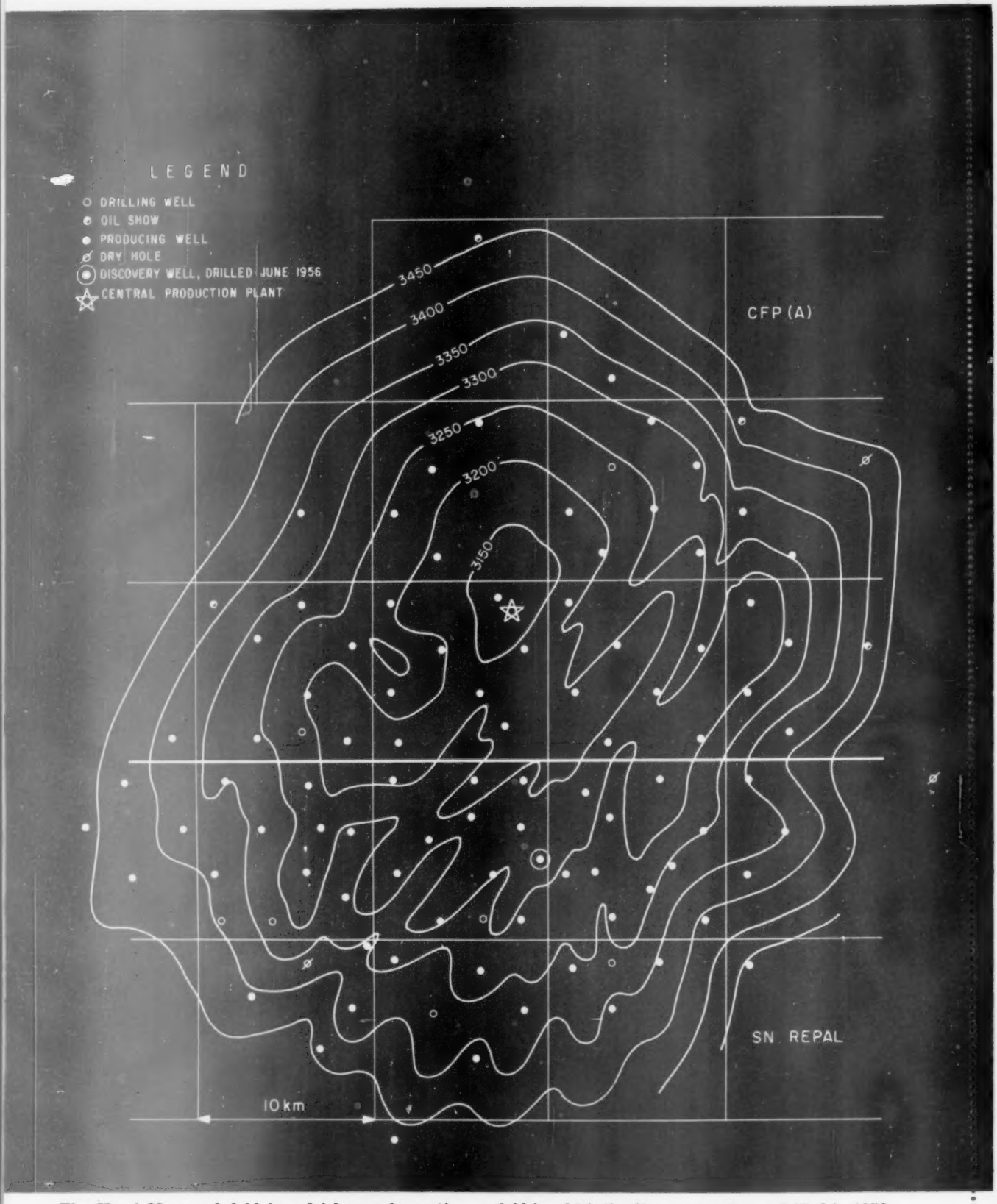
Oil under reservoir conditions has a specific gravity of 0.65. Stock tank oil is about 45.5 deg API. It contains no sulfur.

The reservoir is undersaturated, with the bubble point varying from 2350 to 2840 psi at reservoir temperature of 245 F. Initial pressure was 6810 psi at 10,500 ft subsea. Solution gas-oil ratio is approximately 1405 cu ft per bbl under standard conditions.

Presence of an oil-water contact was revealed by several border wells. Depth of the contact varies, however, with capillary characteristics of the reservoir.

Productivity of the wells, depending on thickness of the pay and permeability, varies greatly. Certain wells can produce only a few

Drilling mud problems are handled in this elaborate mud plant built by CFP(A). The plant is made up of five sections: main storage of products, handling, measuring, fabrication and transport to the field. Storage capacity for liquid mud is 9050 bbl, providing space for all mud returned by the rigs.



The Hassi Messaoud field is a fairly regular anticlinal high with a proved area of nearly 400 square miles. Upper half of the field owned and operated by CFP(A). SN REPAL operates the lower half of the field in which the discovery well was drilled in 1956. Contours, expressed here in meters, are drawn on top of the producing horizon.

hundred bbl a day while others have capacities of 15,000 bbl per day.

In February 1961, the whole field was producing 165,000 bbl per day with 53 wells on production.

Drilling Problems

In early 1957, the two companies decided to develop the Hassi Messaoud field rapidly. All problems were to be solved simultaneously. The companies had to organize an entirely new way of life in the desert, build a big camp for the increased personnel and recruit or train inexperienced French technicians.

Oil field equipment was a problem. For example, there were only a small number of casing sizes available in French mills — 18⅝, 13⅜, 9⅝, 7 and 4½-in. There were at the same time limitations in sizes and types of bits available. Finally, there were only a few big rigs suitable for the Hassi Messaoud problems.

These factors had a large effect upon the methods used by the two companies to solve their difficult drilling problems. Improvements in the bit programs and casing programs largely followed the manufacture of these materials in France.

The typical casing program involves cementing three casing strings.

1. Surface casing is 13⅜-in. set in a 17⅜-in. hole at top of the upper Cretaceous limestone at about 825 ft. It is cemented to the surface and assures shutoff of the upper fresh water zones, avoiding seepage from the continental Tertiary formations. If conditions are very severe, an 18⅝-in. conductor pipe is set to case off loose surface sands which cause lost circulation.

2. Intermediate casing is 9⅝-in. set at about 8250 ft in a 12¼-in. hole at a well-defined geological horizon after entering the lower Jurassic anhydrites. It is set just above the very high pressure (8500 psi) calcium-chloride water-producing zone at about 8500 ft. This string shuts off waters of main cap of the continental intercalary and protects upper lost-circulation zones from heavier mud needed in the following phase. Casing is cemented in two stages with common cement to protect an artesian brackish water zone occuring at 4000 ft. Drilling the 12¼-in. hole is done with jet bits and sometimes with full diamond bits in the anhydrites of the lower Jurassic. Tests with turbodrills have been carried out in some wells in the Jurassic anhydrite but results generally have been disappointing.

3. Production casing is 7-in. set normally in 8½-in. hole at the top of the reservoir at about 11,000 ft. The purpose is to isolate the high-pressure calcium chloride water zone and permit use of an intermediate-density mud during coring and completion operations. It also covers the plastic shale zone encountered in the north and northeast part of the field at about 9500 ft. The string is cemented with a retarded French cement. Normal cementing operations give a cement job covering the interval from the shoe of the 7-in. casing up to the 9⅝-in. casing. Some difficulties were encountered in cementing this string, particularly in the northeast zone where very high mud densities have been necessary. The hard rock part of the 8½-in. hole is almost entirely drilled with full diamond bits. However, some of the massive salt encountered is drilled with long-toothed rock bits.

After the 7-in. casing is set, the producing section is usually cored with diamond core bits. Substantial progress has been made, especially in the very hard Q zone (quartzitic). Average coring rate is now 40 ft per day compared with about 20 ft per day in the first operations.

Normally a liner is not necessary and the well is produced by open-hole completion. However, in a few wells a 4½-in. liner has been found to be necessary. This practice is prescribed in the following cases:

1. When the 7-in. production string is set high, as occurs sometimes in the difficult northeast part of the field, a liner is necessary to isolate the shales immediately above the productive horizon.

2. When the aquifier has been penetrated in flank wells, liners have been set and cemented to permit selective withdrawals from the oil zone.

3. In some wells it is believed hydraulic fracturing may improve productivity. Former trials of fracturing in open hole have been disappointing. However, it was thought a cased well would permit better results by selective fracturing of the best zone or zones. Cost of such a fracturing job is very high and all necessary equipment is not yet available in the field.

Mud Program

The drilling mud program includes four main phases.

1. Fresh water-base mud is used to drill surface hole, set surface casing and drill ahead to about 2000 ft. Lost circulation is frequent in the continental Tertiary or upper 800 ft of this section.

2. Massive salt and anhydrite beds below 2000 ft require use of a salt-base drilling fluid.

Maximum weight advisable during this phase is 11.6 lb per gal. This is due to the hazard of lost circulation presented by several incompetent shales or sands found in the interval between 800 and 7000 ft where the mud is used.

3. The interval between the 9⅝ and 7-in. casings presents three difficulties which make the drilling and cementing of the 7-in. casing very difficult.

The first difficulty is the calcium chloride zone at about 8500 ft with a pressure up to 8500 psi. Permeability and flow potential of this zone vary more or less according to the part of the field. The worst zone seems to be a central north-south strip.

The second problem zone is the plastic shale at about 9500 ft, which is very bad in the northeast of the field. It requires a mud weight up to 18.8 lb per gal.

The third difficulty is lost circulation which occurs with heavy muds in the incompetent Triassic shales and sandy shales at about 10,500 ft. Mud now used in this zone is salt-saturated and weighs about 17.1 lb per gal. A calcium chloride mud has been tried but its control seems to be very delicate. Also, the Triassic shales become unstable when exposed to this mud.

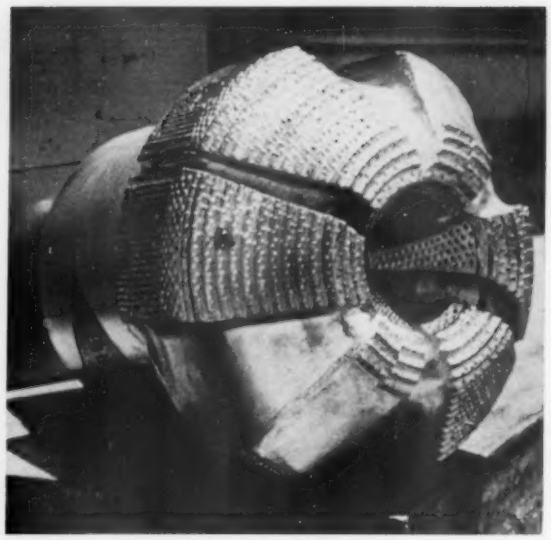
Before the casing is set, the open hole is tested at a pressure varying from 700 to 900 psi. If mud is lost, the fracture is sealed with a cement plug. This operation is repeated until a satisfactory result is obtained.

The mud is then treated carefully for optimum viscosity and gel characteristics. Casing is run very slowly and carefully to avoid pressure surges at the bottom of the hole. Part of the cement is mixed with gilsonite, a lightening and plugging material.

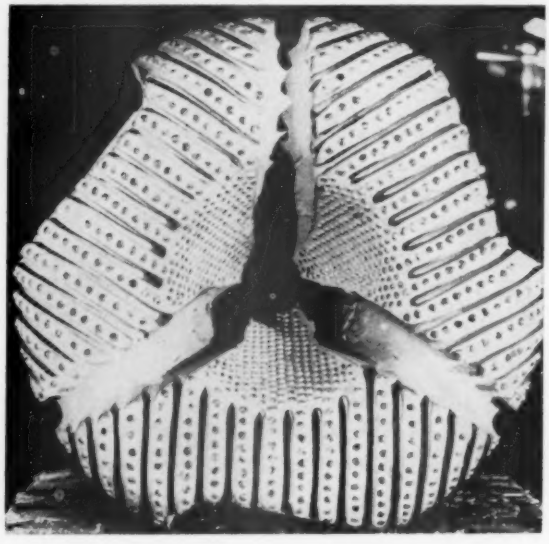
The cement is circulated in place carefully in an attempt to avoid pressure surges. To avoid channeling, pumping rate is increased until a final high cement displacement rate is achieved. This is possible because the cement density is much less than that of the mud.

4. The final phase of the drilling mud program covers coring the productive zone. In order to minimize mud damage to the productive zone, the high density mud is replaced with a freshwater, CMC, low-water-loss emulsion mud. Weight of the mud is maintained at 12.8 lb per gal to contain reservoir pressures. This mud is used until the end of the completion and is sometimes used after treatment as a packer fluid.

An inverted water-in-oil emulsion mud was formerly used, but this gave disappointing results due to instability at the high bottomhole temperatures.



Diamond bits, developed for use with early tests of the turbodrill in Hassi Messaoud, have improved performance of rotary drilling. Diamond drilling is used mainly in anhydrite zones and have resulted in a total savings of around 10 percent per well.

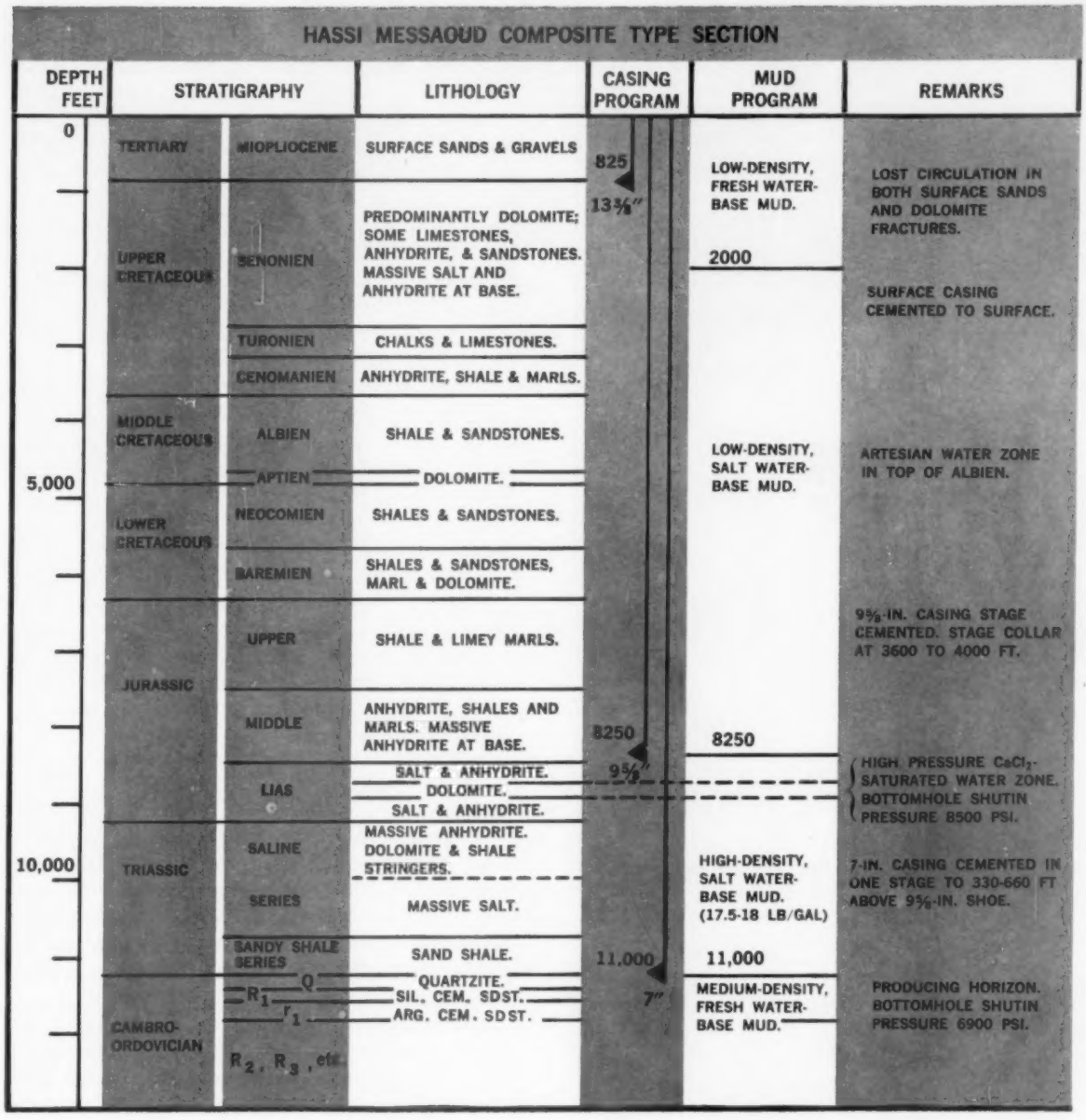


Diamond Bits

One of the drilling techniques developed at Hassi Messaoud is heavy reliance on full-hole diamond bit drilling. In 1957 only 1.09% of the footage was drilled with diamond bits. This figure has increased to 29.4% during 1960.

Diamond drilling in the Hassi Messaoud area had its origin in early tests of turbodrilling. These tests showed clearly that conventional rock bits wore out too fast and a long-life bit was highly desirable. New diamond bits were designed for the turbodrill and subsequently tried in rotary drilling.

For this field, the turbodrill, even with the improved bits, was not competitive with rotary



drilling. However, the bits made for the turbodrill experimental program have helped performance of the rotary drilling method.

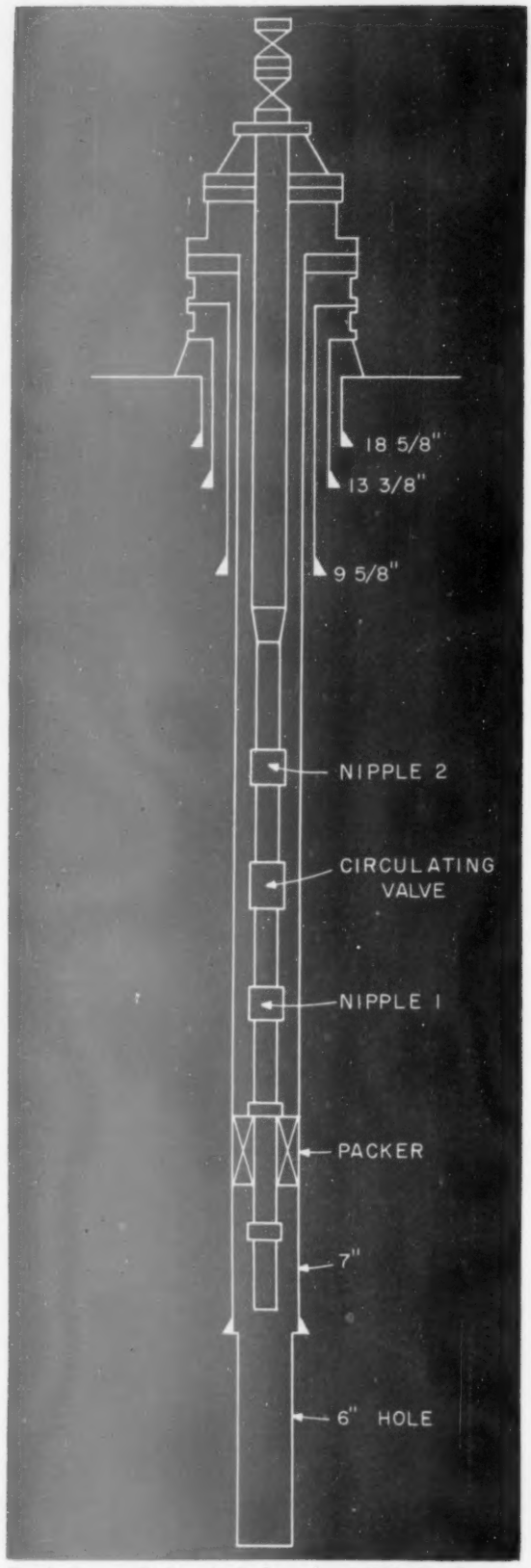
Redesign of the diamond bits resulted from ideas of both CFP(A) engineers and service company personnel.

Diamond drilling has been used mainly in the anhydrite zones of both the 12¼ and 8½-in. holes. Since diamond bits have been used extensively, CFP(A) estimates a saving of 22 drilling days per well. In addition, there is a saving in bit costs. The total gain is about 10% of the average cost of the well. In spite of these improved performances, it is believed diamond drilling rates in certain zones may be increased even further.

Drilling costs, and especially mud costs, have been reduced by several methods. The mud plant of CFP(A) is one of the newest and most efficient ways of achieving this objective.

The mud program involves the use of very heavy muds in the third phase of drilling as described above. Consumption of this mud is abnormally high because of lost circulation. Also, after the 7-in. casing is set, this expensive mud is lost if special storage is not provided Other drilling mud problems, such as the change of the mud at 2000 ft and lost circulation in the surface zones, can frequently be a source of lost rig time.

To decrease lost rig time and reduce mud expense, CFP(A) decided to treat this as an



Typical completion includes about 300 ft of open hole. String of 13⅜-in. casing extends to about 825 ft; 9⅝-in. casing is run to near 8250 ft; the 7-in. string extends to the producing formation.

industrial problem by designing and building a complete mud service plant. The plant, put in service at the end of 1958, is made up of five sections — main storage of products, handling, measuring, fabrication and transport to the field. Storage capacity for liquid mud is 9050 bbl, providing space for all mud returned by the rigs.

Recently, two large-capacity centrifuge units have been added to this installation. This facilitates treatment of heavy muds and permits salvaging additional barite.

In addition to salvaging used muds, the plant has permitted a reduction in the cost of mud products storage, transportation to the rigs and the cost of fabricating muds and has resulted in an increase in the quality of the different types of mud. Also, rig time for conditioning mud has been almost completely eliminated. On CFP(A) rigs, this amounts to about four days per well.

Since beginning of the field's development, substantial progress has been made by the two companies in time required to complete development wells. For example, time required to drill, evaluate and complete the average well in early 1959 was 190 days. This figure was reduced to 100 days by the end of 1960.

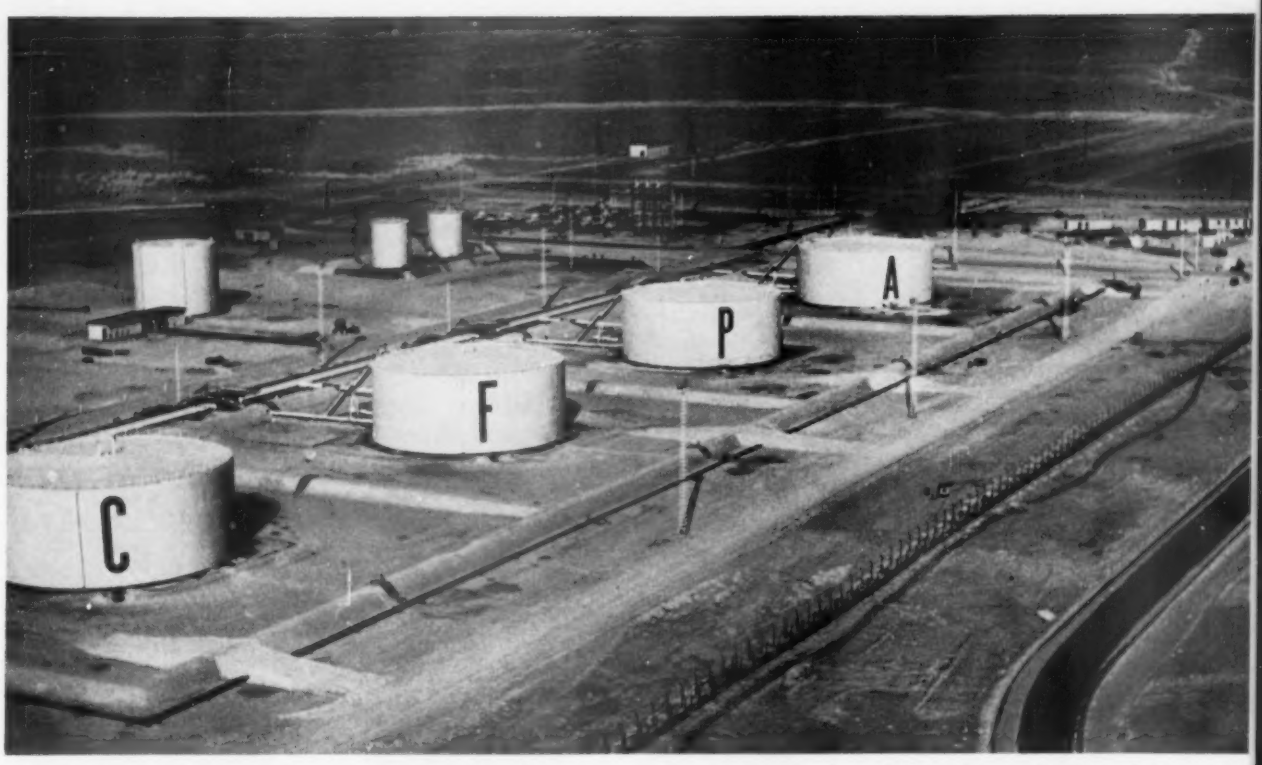
Producing Problems

The majority of the wells in Hassi Messaoud have permanent type completions. All wells flow with a tubing pressure greater than 800 psi. CFP(A) and SN REPAL have separate gathering systems and unitized separation facilities. Only the CFP(A) installations are described here.

The standard completion equipment of a producing well is illustrated. The packer is set on wire line. Because of tubing joint leaks that occured with API standard joints on some of the first wells completed, most tubing strings are now equipped with special teflon gasket joints.

Tubing size depends on productivity of the well, which varies largely from one well to another since the core analysis is not sufficient to estimate productivity accurately. A drillstem test with hook-wall packer is normally run prior to completion. This test is basis for tubing size selection. High friction losses require 4½-in. tubing for flow rates in excess of 4500 bbl per day. For intermediate capacity wells, 3½-in. tubing is sufficient. Wells producing less than about 1500 bbl per day are normally equipped with 2⅞-in. tubing. A packerless completion is sometimes used for non-producing, observation wells.

A packerless completion is also planned to de-



Central production plant receives production from all CFP(A) wells. The plant is designed for 107,000 bbl per day and permits testing, separation, storage and measuring of all oil before it is sent to the pipeline pump station.

termine the practicality of production through the annulus. The objective here would be to reduce friction losses and number of sizes of tubing in use.

One of the most difficult choices the CFP(A) faced in the field was that of a packer fluid or packer mud. To maintain adequate well safety, weight of this fluid should be about 13 lb per gal. In most cases (2⅞ and 3½-in. completions), a bentonite-CMC water-base mud of this weight is used. In the rare 4½-in. tubing completions where workover jobs in the 7-in. casing are expected to be difficult, salt water (10 lb per gal) is used as the annular fluid.

The same size wellhead is used for both 2⅞ and 3½-in. tubing completions on producing wells. All producing wells have two master valves, a swabbing valve and usually two wing valves and a dual tie-in to the pipeline.

CFP(A) wells are individually connected to a separation center by pipeline. This plant is designed for 107,000 bbl per day and permits testing, separation, storage and measuring.

Produced crude oil arrives at the separation plant manifold at a pressure of about 500 psi. From this point, the individual well production can be sent to the main battery of separators or to the test separators where each well can be individually tested.

After three stages of separation, the oil is sent to storage tanks where production is gaged. Then a pumping station sends it through eight miles of 20-in. line to the Haoud El Hamra pipeline station. This is operated by SOPEG, jointly owned by CFP(A) and SN REPAL. Part of the gas is used in gas turbines at Haoud El Hamra electrical plant. The remainder is now being burned, but its reinjection into the reservoir is under study.

The production plant is centrally located in the field (see map). Forty individual wells can now be connected to the plant but this number can be increased by enlarging the manifold. In some cases, several wells arrive at one manifold station with the test line arriving at a second point.

Diameters of the gathering lines are 4, 6 and 8 in. according to the productivity and distance of the wells from the production plant. Gathering lines in most cases are located on surface of the ground, but a few lines to big producers have been buried because of a minimum separator temperature limitation during the winter months.

The manifold of 40 three-way valves allows the stream from any well to be sent to the main separator battery, to the test separator unit, or directly to the second stage separators.

Degassing in most cases is made in three stages. The first stage consists of four separators designed for 500 psi pressure. The second stage is made up of four separators with rated working pressure of 85 psi. The third stage functions at nearly atmospheric pressure. Degassed oil flows into either of four 50,000-bbl storage tanks. Most gas is flared, although a small fraction is sent to SOPEG for generation of electricity.

Wells are tested in a supplementary three-stage separator battery working at 500 psi, 85 psi and atmospheric pressure. Oil leaving the test unit is gaged in either of two 5300-bbl tanks and then pumped to the main storage tanks.

Oil is pumped with three 160-hp centrifugal pumps driven by electric motors. These pumps, installed 20 ft below the storage tank level, send the crude through the 20-in. buried line to Haoud El Hamra.

Salt Water Problem

The present separation plant performs satisfactorily. However, minor changes are being made to allow better isolation and treatment of production from wells producing some salt water.

Some edge wells produce a very small amount of salt water. However, this water is saturated under reservoir conditions (estimated 358,000 ppm salt). Thus a small amount of water production can lead to a high salt content in the oil. For marketability, salt water content of the oil must be below 0.02%. The separation problem is made more severe by the formation of a very tight oil-water emulsion under these conditions. Consequently, chemical treatment of the oil is necessary to break the emulsion and facilitate desalting.

Some wells producing about 0.3% salt water develop a salt deposit in the tubing. This is evidenced by a frequent and large variation of tubing pressure. The variation may be as great as 1000 psi at 10 or 15 min intervals. An intermittent washing of tubing and open hole with fresh water dissolves the salt. A normal well production interval of possibly a few weeks then follows.

In one particular well, salt water production increased to about 5%. Salt crystallization in the tubing caused rapid and nearly complete plugging. Subsequently, injection of chemically treated fresh water through the annulus for dilution of produced fluid at the bottom of the tubing has permitted normal production. Nevertheless, to reduce operating costs a workover is being considered for this well to plug the bottom section with a liner.

Asphalt deposits in the tubing of some wells reach serious proportions. This varies from well to well with no satisfactory explanation yet being found for the phenomenon. Important factors seem to be the amount of free gas, pressure, temperature and degree of turbulence. The deposit is hard and is usually found in the upper two-thirds of the tubing. When the flowing tubing pressure decreases substantially, signaling reduced production, elimination of the deposit is necessary.

Deposits are removed by both mechanical and chemical means. Mechanical treatment involves running a specially designed scratcher device through the tubing using a wireline unit. Chemical treatment consists of pumping a solvent into the tubing and open hole.

Injection of surfactant-treated solutions into the formation has given encouraging results in some cases. Treatment of some wells is necessary at ten-day intervals. Other wells require monthly or even less frequent treatments.

Several stimulation techniques have been tried on wells at Hassi Messaoud. None has shown prospects of major well productivity improvement.

Several wells have been hydraulically fractured with gelled water and sand quantities ranging from 22,000 to 40,000 lb. Little or no increase in well productivities was obtained. However, this does not mean that the method is not applicable at Messaoud. It does suggest, however, that major alterations in fracturing procedures are necessary for successful application.

The field is being produced at the present time by natural depletion. The actual production rate of individual wells is such as to arrive at an average reservoir pressure of approximately 4500 psi in 1968. Full pressure maintenance by gas injection is being considered for this date. Partial pressure maintenance by reinjection of produced gas is being considered for 1963.

The objective here is to increase interim production and to develop field data to help evaluate the economics of the full pressure maintenance project. In the meantime, a more precise estimate will be made of the water-drive contribution and low permeability strata contribution to ultimate recovery from the reservoir.

The author is Chief of the Technical Department, Compagnie Francaise des Petroles (Algerie), Algiers.

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Aluminum flowline was welded at two stations along the 5700-ft line and was then pulled over the mountainous terrain into the ditch. Flexibility of aluminum pipe eliminated necessity of mechanical pipe-bending equipment.

Aluminum Flowline Passes Test

by William R. Lambert

Why has United Fuel Gas Company installed the first all-aluminum welded flowline in the Appalachian area? The company believes that if an aluminum line is successfully laid in this rugged area, and does not experience corrosion damage, then an aluminum line can be constructed anywhere in the company's system.

United Fuel has achieved the primary objectives of the test line: to confirm corrosion resistance qualities and cathodic protection requirements, as well as to establish procedures for handling and installing aluminum line pipe as compared with steel line pipe.

This first aluminum line transports natural gas about one mile from a new production well to the company's gathering system near the mining community of Phelps, Ky.

The particular site was selected to test installation in rugged terrain and to determine performance in many different corrosive environ-

Automatic welding machine was used to weld aluminum flowline in United Fuel Gas' test installation. The machine, weighing 65 lb and operated by a conventional power source, completes a 4-in. joint in approximately 2 minutes.

ments. Obstacles include mountain slopes in excess of 50 deg, coal seams, dirt, clay, rock, a stream and a road crossing.

Choosing the Pipe

The 5700 ft of Schedule 40, 4½-in. OD pipe known as 6061-T6 alloy was supplied in 40-ft lengths. The pipe is designed with standard pipe wall thickness at the ends and a thinner wall for the rest of the joint length. At the pipe ends, wall thickness is 0.237 in. For the remainder of the joint, wall thickness is 0.150 in. The OD at the ends is 4.5 in. and the OD of the remainder of the joint is 4.326 in.

Thicker walls at the ends of joints compensate for reduction in strength of heat-treatable aluminum alloys caused by heat of welding. Tensile strength of 6061-T6 aluminum alloy is reduced in a local area by approximately 37% during circumferential welding.

Why Aluminum?

Before a final decision was made to lay an aluminum line, several questions arose and for the answers we went to experts in the aluminum industry. Some of the questions and answers were:

Q. Will aluminum pipe pit when buried in a ditch where there is little oxygen?

A. Oxygen should make little or no difference.

Q. Will aluminum pipe require special ditch padding?

A. No, treat it the same as steel.

Q. Will aluminum pipe require special measures during backfill?

A. No, aluminum can be treated the same as steel.

Q. What effect will coal seams, gob piles, mine water and its related SO_2 have on aluminum pipe?

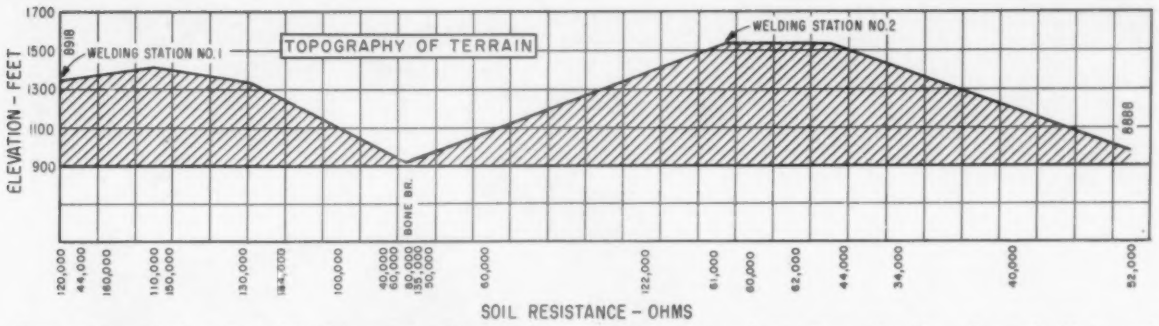
A. They should offer no trouble.

Q. What effect will alkaline soil have on aluminum pipe?

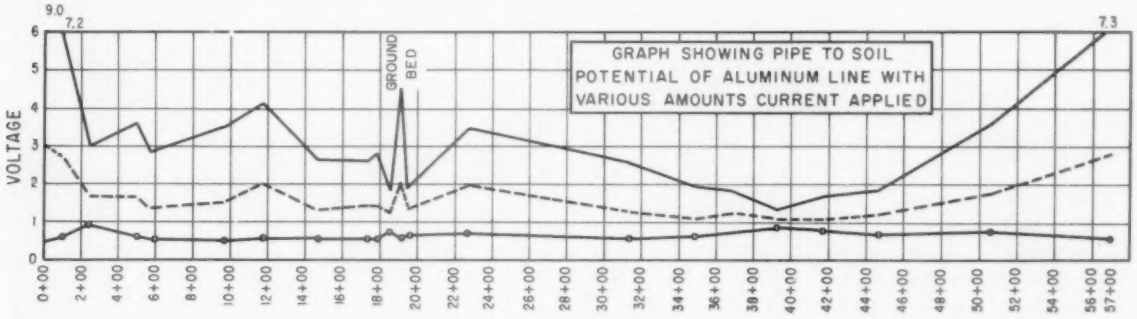
A. No more likely corrosion than a neutral soil.

Q. What effect will stray-currents have on aluminum pipe?

A. Practically the same as on steel pipe, inasmuch as the stray-current should be bonded back to the source through an electrolysis switch. Over-protection could result if too much current in a small area is involved.



Rugged terrain is reflected in this graph of line elevation. Figures at bottom of graph represent soil resistance in ohms along the line through dirt, coal seams, clay, rock, a stream and a road crossing.



Pipe-to-soil potential along aluminum line is shown with 16 amps of impressed current (upper curve), 4.4 amps (middle curve), and static conditions (lower curve). Current was applied at the ground bed located at station 19+00.

Q. Will some areas of the aluminum pipe require external coatings?

A. Provided some cathodic protection current is applied in potential corrosive areas, only the very severe hot spots should require coating.

Q. Will the aluminum pipe require cathodic protection in the form of magnesium anodes?

A. Perhaps, but the number of anodes required should be much less than that required for bare steel.

Q. Can aluminum pipe be over-protected and what effect would it have on the pipe?

A. Yes, it can cause cathodic corrosion. It is thought that potentials above 1.2 volts would be over-protection.

Q. What effect will foreign line crossings have on aluminum pipe?

A. Care should be taken that the two lines do not touch. If the foreign line is under protection by impressed currents, proper bonds should be made.

Q. What effect will salt water have on aluminum pipe?

A. Very little, if any. Salt is not troublesome for aluminum.

Q. What is the maximum yield strength and tensile strength of the 6061-T6 type aluminum alloy pipe, as well as its bursting pressure?

A. 35,000-psi minimum yield, 38,000 psi minimum tensile. Bursting pressure is approximately 2200 psi.

After the decision was made to install the all-aluminum line as a test line, aluminum alloy, 6061-T6 pipe was selected. The manufacturer supplied the pipe and, for the welding, furnished an automatic inert-gas consumable-electrode welding unit, complete with its own power supply.

Automatic Welding

The welding unit was an automatic pipe welder weighing approximately 65 lb and operated by a conventional power source. The unit operates on the inert-gas shielded metal arc-welding process, and is capable of making a complete weld in one continuous operation. On 4-in. pipe, welding time was approximately 2 min per joint.

A 2-lb spool of electrode wire 0.035-in. in diam welded 30 to 35 joints before changing spools. The argon gas shield passes around the

Helicopter transports a bundle of 40-ft joints of aluminum pipe, illustrating the ease with which pipe can be moved into rugged territory. Photo courtesy of Aluminum Company of America.

electrode and through the torch cover. This gas helps cool the torch and envelopes the arc to prevent oxidation of the molten aluminum.

Construction

This line originates at United Fuel's well 8918 and travels up and over two mountain ridges terminating at UFG well 8888. The line goes through three changes of elevation of approximately 600 ft and several slopes in excess of 50 deg.

Clearing rights of way and ditch preparation were the same as followed for conventional steel line. The normal procedure in constructing a steel line from this point would be:

1. Joints of pipe are strung along the ditch line.
2. Each joint is tailored to fit the ditch by bending with a flexible bending shoe mounted on a side-boom. It is estimated that on a typical line in this area it is necessary to make bends for every 40-ft joint of pipe installed.
3. Welding equipment is moved to each joint and welding is completed over the ditch.

The following procedure was adopted for the construction of the aluminum flow line:

1. Two welding stations were selected. Station No. 1 was located at well 8918 on survey station 0+00. Station No. 2 was located on top of the next mountain at survey station 35+50. Of the estimated 150 welds made in the fabrication of this line, 145 were made at one or the other of these two welding stations.

2. Pipe, packaged four 40-ft joints to a bundle, was moved onto each welding station location. The welding machine was set up on location No. 2.

3. Each joint was lined up using internal line-up equipment and a back-up ring. Internal line-up equipment was removed after the root pass was made.

4. The welded pipe was then pulled through the welding station. (It is not intended to imply that station welding is not possible with steel pipe. However, in United Fuel Gas Co.'s operating area, it is the exception rather than the rule.)

5. From station No. 2, 2740 ft of line was welded — 1050 ft pulled to the west and 1690 ft pulled to the east.

6. Welding equipment was then moved to station No. 1 and 1860 ft of pipe was welded and pulled into the ditch.

7. Welding equipment was moved into Bone Branch where the road and stream crossing was fabricated, completing the welding on the line.

The pipe handled easily and conformed to the ditch with few exceptions. In the few instances where better conformity to the ditch was required, sand bags were used. Only two mechanical bends were required. Both were at the Bone

Cathodic Protection Survey — United Fuel Gas Aluminum Flowline.

Survey station number	Test station number	Static potential —volts	Anodes connected potential —volts	Anode output current —ma	Pipe-to-soil potential (Impressed current at ground bed) —volts				Remarks Well 8918 flange
					16a	8a	5a	4.4a	
0+00	Flange	—0.50	—	—	9.00	5.00	3.40	3.10	Pipe out of ground.
1+00	1	—0.65	—0.72	—	7.20	4.30	2.90	2.65	Pipe out of ground
2+00	2	—0.64	—0.70	4.4	3.10	2.15	1.75	1.60	Pipe buried.
5+00	1" Tap	—0.55	—0.61	—	3.70	2.30	1.70	1.60	
5+60	3	—0.59	—0.61	—	2.90	1.85	1.40	1.30	
9+75	1" Tap	—0.74	—0.79	—	3.60	2.30	1.65	1.50	
11+40	4	—0.67	—0.68	0	4.20	2.70	2.10	2.00	Anode lead broken.
15+50	5	—0.73	—0.74	9.0	2.60	1.80	1.45	1.35	
17+75	6	—0.69	—0.75	4.3	2.65	1.90	1.55	1.44	
18+15	7	—0.72	—0.74	—	2.70	1.85	1.50	1.45	
18+60	Stream	—0.63	—0.69	—	1.85	1.45	1.30	1.25	Bone Branch.
19+00	Ground bed	—	—	—	—	—	—	—	
19+20	8	—0.61	—0.64	—	4.55	2.90	2.90	2.05	
19+50	9	—0.70	—0.73	0	1.90	1.55	1.40	1.35	Anode lead broken.
22+75	10	—0.64	—0.72	8.4	3.45	2.45	2.05	1.95	
31+15	11	—0.56	—0.60	6.0	2.60	1.70	1.35	1.28	
34+80	12	—0.55	—0.65	8.0	1.95	1.40	1.15	1.10	
36+00	1" Tap	—0.73	—0.74	—	—	—	—	—	Covered with dirt.
36+80	13	—0.82	—0.83	7.0	1.85	1.45	1.30	1.25	
39+10	14	—0.80	—0.82	12.0	1.35	1.17	1.10	1.08	
41+75	15	—0.65	—0.73	12.0	1.70	1.30	1.10	1.07	
44+60	16	—0.71	—0.83	24.0	1.85	1.40	1.20	1.20	
50+75	17	—0.68	—0.69	2.0	3.65	2.45	1.95	1.76	
57+00	Flange	—0.70	—0.76	—	7.3	4.2	3.0	2.8	End of line well 8888.

Branch stream and road crossing where relatively sharp bends were required.

The line was hydrostatically pressure tested to 1525 psig for 24 hr by injection of water at Bone Branch.

Station welding is practical with aluminum, where it might not be with steel, because of aluminum's lower modulus of elasticity (10×10^6 psi for aluminum; 30×10^6 psi for steel). This permits the aluminum to contour itself to the ditch line elastically by its own weight, or in a few instances, with the use of sand bags. Steel pipe would have required permanent mechanical bends.

Much was learned during the initial construction relative to what aluminum pipe would and would not do in rugged terrain. Periodic tests and inspections will be made of the line, from the standpoints of corrosion and physical characteristics, to determine its effectiveness.

Corrosion Tests

In a non-stray current area, the soil through which the flowline passes is the most important environment confronting the line from the corrosion viewpoint. Several years ago it was thought that soils with resistivities above 10,000 ohm-cm would cause little damage to buried metals. Today this theory has been abandoned. The trend now is to concentrate, not primarily on the magnitude of the soil resistance above or below a certain level, but on the amount of variation in the soil resistivity. These galvanic cells can be active in adjacent soils of 100,000 ohm-cm to 60,000 ohm-cm, just as easily as in soils between 1000 ohm-cm and 6000 ohm-cm.

Variations in moisture content, salt concentration, degree of aeration and specific gravity also determine corrosive properties of the soil.

Many tests have been made over the years to determine resistance of aluminum to corrosion in various soils and which alloys are best suited for underground use. In general it has been found that soils which are aggressive to steel are likely also to be aggressive to aluminum, but to a much lesser degree, due primarily to the oxide film on aluminum.

After the right of way had been cleared, but prior to welding the pipe, a soil-resistance survey was conducted. Measurements were made every 50 ft along the right of way and the results were plotted. Soil resistivity varied from 276,000 ohm-cm to 26,000 ohm-cm. There were several coal seams, natural drainage slopes and a stream crossing with a pH of 7.2. As a result of the survey, thirteen 17-lb high-potential magnesium anodes were installed along the right of way in the lowest resistivity areas and where sudden changes in resistivity were noted. Anode leads were brought to a test station as was a No. 8 wire from the pipe but the anodes were not immediately connected to the wire

from the pipe. The aluminum line was electrically insulated from the steel line tie-in points on both ends of the line by insulated flanges. The flanges were not buried.

Eight weeks after the line was completed and backfill had settled, a pipe-to-soil potential survey was conducted over the line using a high-resistance volt-meter in conjunction with a copper sulphate half-cell. Readings were secured at least every 50 ft along the line. A stake was placed in the ground at the exact location where the half-cell had been placed when the readings were taken, so that when potential readings were made later with the anodes connected, the copper sulphate would be placed in the same spot with relation to the flowline.

Potential readings were then plotted on the same graph as the soil-resistance readings. Potential readings varied from 0.525 v to 0.820 v. It was interesting to note that although there was a difference of 0.295 v, the change was very gradual with no sharp peaks. Anode wires in the test stations were then tied electrically to the No. 8 wire from the flowline. After a 24-hr period a potential survey was again made over the flowline using the same instrumentation and the half-cell in the same place. These potential readings with anodes attached were then plotted on the same graph as the soil-resistance readings and potential readings with the anodes not attached. Results indicated a negative shift in pipe-to-soil potential along the length of the line. The shift was small in amplitude, being approximately 0.04 v over most of the line. Total output of all 13 anodes was only 97.1 milli-amps.

Because of the low output of the magnesium anodes it was decided that, in order to determine the amount of current required for protection of the aluminum line, it would be necessary to install a temporary ground bed and impress current on the line. As a result, four months after the line was fabricated, an impressed current ground bed was set up at approximately the mid-point of the line and corrosion tests conducted.

Current was applied to the ground bed in various increments, and pipe-to-soil voltages were secured on the aluminum line at each test station along the length of the line.

It is believed that cathodic protection on aluminum pipe is established when the pipe-to-soil potential is between –0.90 v and –1.20 v or the static pipe potential is increased by a –0.30 volts. As can be seen in the accompanying table and curves, when 16, 8, 5 or 4.4 amps were impressed on the ground bed, pipe-to-soil potential was well above –0.90 v, providing the –0.30-v increase.

What Tests Reveal

As a general rule, current requirements for a mile of 4-in. bare steel pipe in similar soil conditions would be between 6 to 8 amp. The current requirements for a mile of 4-in. coated steel pipe would be between 0.5 to 1 amp, and from the information gathered during the tests it appears that a mile of 4-in. aluminum pipe can be placed under protection with the application of 2 to 3 amps.

The conclusion is that aluminum oxide on aluminum pipe affords a protective coating which is much better than no coating on steel pipe, but not as good as a good coating on steel pipe.

It is believed that if an aluminum line is to be installed as a permanent structure, the line could be buried bare in most areas where steel would require coating, but in the very severe corrosive areas, the aluminum line should be coated with tape.

These initial corrosion tests do not prove or disprove conclusively the ability of aluminum pipe to resist corrosion in various environments. However, the line and tests to date do offer a basic starting point for evaluation of aluminum in soil conditions relative to those encountered in the Appalachian area.

About the Author

William R. Lambert is corrosion engineer of the Production and Storage Department, United Fuel Gas Company, Charleston, West Virginia. He attended West Virginia University and Temple University, received a BS degree at Temple in 1951. Prior to his affiliation with United Fuel in 1956, he was a corrosion engineer with Texas Eastern Transmission Corp. He is a member of AIME, AGS, present chairman of the Kanawha Valley chapter of NACE, and past chairman of the Southern West Virginia Corrosion Coordinating Committee.

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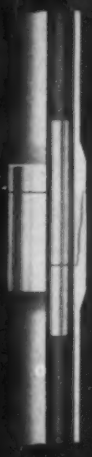

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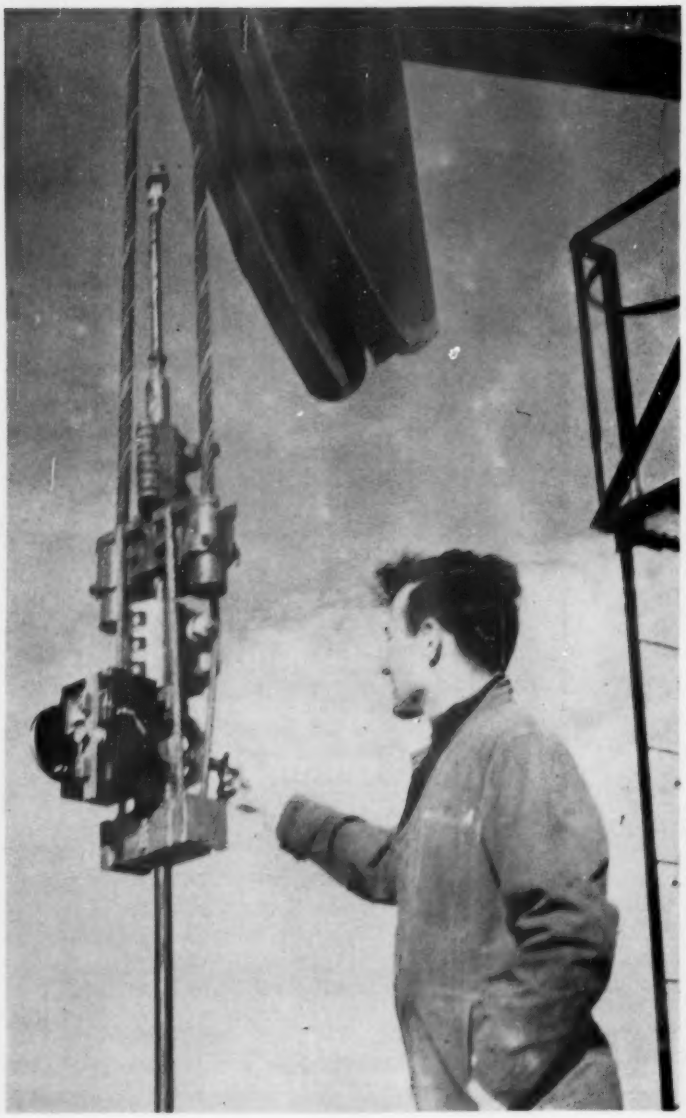
Referred to as the impulse factor (IF) and the counterbalance factor (CF), they incorporate many of the complex variables in beam pumping that heretofore have made exact calculations not only difficult but time consuming.

Both factors are based on statistical analysis of some 1500 dynagraphs of pumping wells. Their use has given reliable results in a wide variety of field applications.

Five of the weighted variables included in these dynamic or motion factors are: (1) friction of oil in the tubing and rod friction against the tubing; (2) buoyancy of rods in oil and a small correction on the downstroke; (3) inertia of moving parts; (4) pumper geometry (proportions of components can affect greatly the rate of acceleration and polish rod load at certain points in the stroke); and (5) longitudinal vibration (polish rod loads and pump performance vary considerably as pumping speeds pass through resonant and non-resonant conditions). All of these effects were given reasonable weight in determining the impulse and counterbalance factors.

Load measurements in these studies were made with a torque meter on the V-belt sheave of the unit gear reducer. Conventional dynamometer measurements were made also on the polished rod.

The basic load used in this analysis is the weight of the sucker rod string. As the polished



Most accurate method of checking well loads is by means of a dynamometer, using torque factors of the pumping unit.

another
TRETOLITE SERVICE
report

Squeeze Treatment Doubles Oil and Gas Production

The treatment of nine wells on a Texas lease was simple, effective and low in cost—about $300 to $350 per well for TRET-O-LITE demulsifying chemical, pressure pumping truck, and vacuum tank truck. Most of the wells were completed through tubing, with packers set above perforations. Several were dual completions, with two strings of tubing and producing zones separated by packers.

How Tret-O-Lite Chemical Demulsifier was used*

Thirty gallons of TRET-O-LITE demulsifying chemicals were mixed with sixty barrels of lease crude (40° API). This mixture was pumped into tubing of each well, followed by enough crude to allow about 300 feet of oil-chemical mixture to stand in tubing. Each well was then shut in for 18 to 24 hours.

Pays for itself in two days

The figures in the table show how effectively the TRET-O-LITE squeeze treatment increases production in the nine wells.

The increase in production was sufficient to pay for the cost of the total squeeze job in about two days.

WELL	DEPTH	MAXIMUM INJECTION PRESSURE	PRODUCTION BEFORE SQUEEZE		PRODUCTION AFTER SQUEEZE		GAIN BBLS. DAY
			BBLS. OIL / DAY	MCF GAS / DAY	BBLS. OIL / DAY	MCF GAS / DAY	
1	9642	4800	34	153	61	593	27
2	8381	3000	30	5	52	83	22
3	9640	3600	35	224	87	323	52
4	9625	4500	40	672	50	497	10
5	8484	3700	27	339	51	700	24
6	9652	3000	53	35	83	353	30
7	8397	5200	30	32	125	238	95
8	8408	3800	15	12	129	94	114
9	9310	3600	0	0	123	760	123
		TOTAL	264	1472	761	3641	497

Tretolite products are helping to achieve similar savings for thousands of other producers. To find out how you can profit, *ask the Man in the Red Car.*

Or write to . . .

*Registered trademark, Petrolite Corporation

TF-60-6

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"Why Baker Differential Fill-Up Equipment belongs in your next casing string..."

Product 1091 M&F

This precise mechanism automatically fills your casing from the bottom, constantly adjusting the rate of fill to provide maximum relief from destructive pressure surges—regardless of the depth to which it is run.

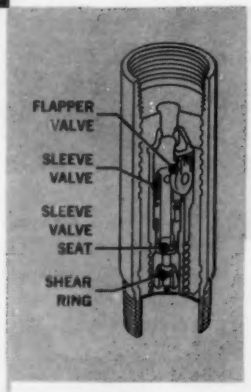
This means you can land casing faster, saving up to 50% on running-in time. This is because you eliminate time-consuming surface filling, and because you can run fast through weak or permeable formations without fear of damaging them. You protect the productivity of your well, and lessen the causes of blowouts, too. The Differential Valve is designed to allow only a 90% casing fill; and, when the rate of lowering slows or stops, the valve closes. Baker Differential equipment thus provides positive action to prevent overfilling.

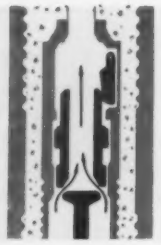
Baker Differential Fill-Up Shoes and Collars may be used in combination, giving the protection of two back-pressure valves and 81% fill.

Yes, Baker Differential equipment belongs in your next casing string—for many reasons. To get the complete story on both regular and circulating Differential, call your Baker man.

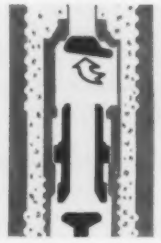
What's in a name?

"Differential" doesn't always mean the same thing. In certain equipment it means little more than providing a *fixed* difference by means of a spring. *Baker Differential* works on a difference in areas to balance casing fill with the fluid in the annulus. It takes into consideration differences in depth and running-in speed. It gives instantaneous relief at the point where pressure surges occur—below the shoe. The *difference in differential* is important. Specify *Baker Differential* Equipment.





RUNNING-IN Flapper Valve held open. The Sleeve Valve constantly adjusts fluid entry to maintain the proper rate of fill.



BACK-PRESSURE VALVE Pressuring the casing shears Ring and releases Flapper Valve for cementing or floating. No ball to drop.

DIFFERENTIAL FILL-UP EQUIPMENT

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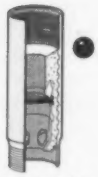
BAKER

COLLARS

Differential Fill-Up Collar
Product No. 1091 M&F

Flexiflow Fill-Up Collar
Product No. 161 M&F



Circulating Flexiflow Fill-Up Collar
Product No. 161-D M&F

Cement Float Collar
Product No. 101 M&F

Cement Baffle Collar, with Hole
Product No. 104 M&F

Insert Valves, Float-Check Type
Product No. 176 and Flexifill Type
Product No. 177

Triplex Flapper Valve Float Collar,
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BASKETS

Metal Petal Basket, with Stop Rings
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Product No. 330

Avoid welding . . . lock casing shoes and collars with BAKERLOK Thread-Locking Compound Product 050

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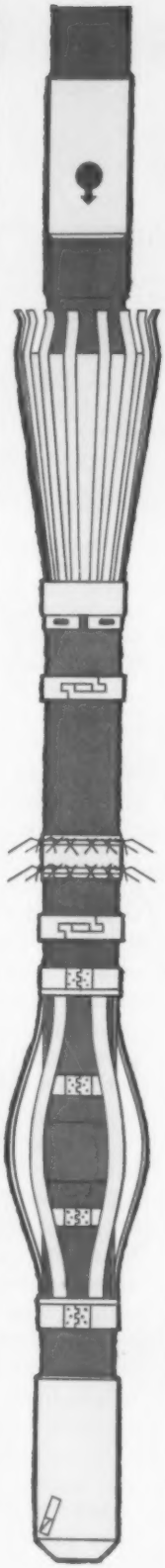


SCRATCHERS

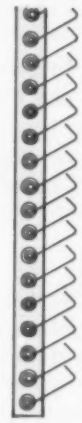
Hinge-Lok Wall Scratcher, with 4½" long wires
Product No. 900-C

Hinge-Lok Wall Scratcher, with 2½" long wires
Product No. 900-C

Solid-Ring Wall Scratcher, with 4½" long wires
Product No. 901-C

Solid-Ring Wall Scratcher, with 2½" long wires
Product No. 901-C

Hammer-Lok Stop Rings
Product Nos. 940-B (Solid) and 945-B (Hinged)



Rotating Wall Scratcher
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Product No. 910-G

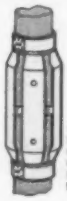
"HN-15" Solid-Ring Casing Centralizer
Product No. 908-HN

"HN-20" Solid-Ring Casing Centralizer
Product No. 908-HN

"H-15" Hinge-Lok Casing Centralizer
Product No. 9115

"H-20" Hinge-Lok Casing Centralizer
Product No. 9112

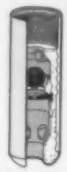
"H-25" Hinge-Lok Casing Centralizer
Product No. 9113



Hinge-Lok Rigid Casing Centralizer
Product No. 9133

SHOES

Differential Fill-Up Shoe
Product No. 1081



Flexiflow Fill-Up Shoe
Product No. 160

Cement Float Shoe
Product No. 100

Cement Wash-Down Whirler Float Shoe
Product No. 120

Cement Bull Plug Shoe
Product No. 103

Cement Guide Shoe
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Triplex Cementing Shoe
Product No. 1363

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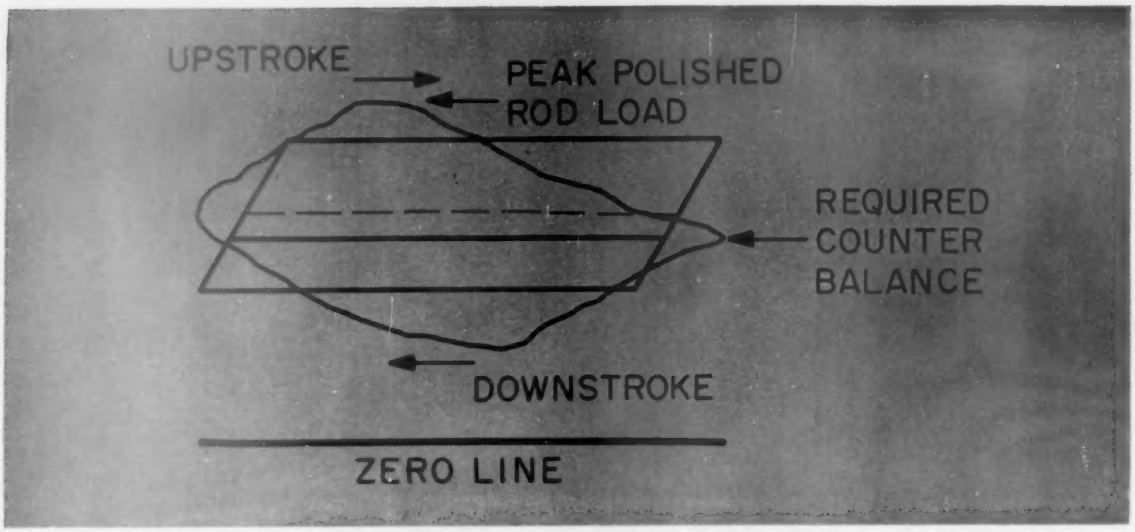


Fig. 1. The parallelogram illustrates static loads on beam pumping units, at extremely slow speeds, with inclined ends indicating rod stretch and contraction. At higher speeds, dynamic effects produced by polished rod acceleration, inertia, friction, rod string vibration, rod stretch, etc., change the shape of the "card" and produce a peak load on the upstroke. Unknown effects on the first half of the upstroke load are combined in an "impulse factor" (IF). The inverted peak on the downstroke reduces the load. The required counterbalance, which drops below theoretical value with increasing speed and longer strokes, is provided for by "counterbalance factor" (CF).

rod moves upward, the traveling valve closes to add a load equal to the force caused by the head of fluid acting on the net pump plunger area. (Use of a tapered rod string requires a small correction for the upward force acting on the difference in cross-sectional areas of the two rod sizes.) At extremely slow operating speeds, this load is the weight of the rods plus the fluid weight. As the polished rod starts on the downstroke, the standing valve closes and the traveling valve opens, transferring the fluid load from the plunger to the tubing.

As stroke length and frequency are increased, a dynamic effect is superimposed on the static parallelogram chart in Fig. 1. This tends to increase upstroke loads and decrease downstroke loads. Rod stretch and contraction as the load is picked up and released are also important factors.

Dynagraph readings showed that the dynamic effect on the upstroke was a function of polished rod acceleration, inertia, friction, rod string vibration, rod stretch, etc. For simplicity of application, and with reasonable accuracy, all of these unknown effects on the first half of the upstroke load were combined in an empirical "impulse factor" (IF). These factors were determined for various combinations of stroke lengths and frequency. They are given in Table 1.

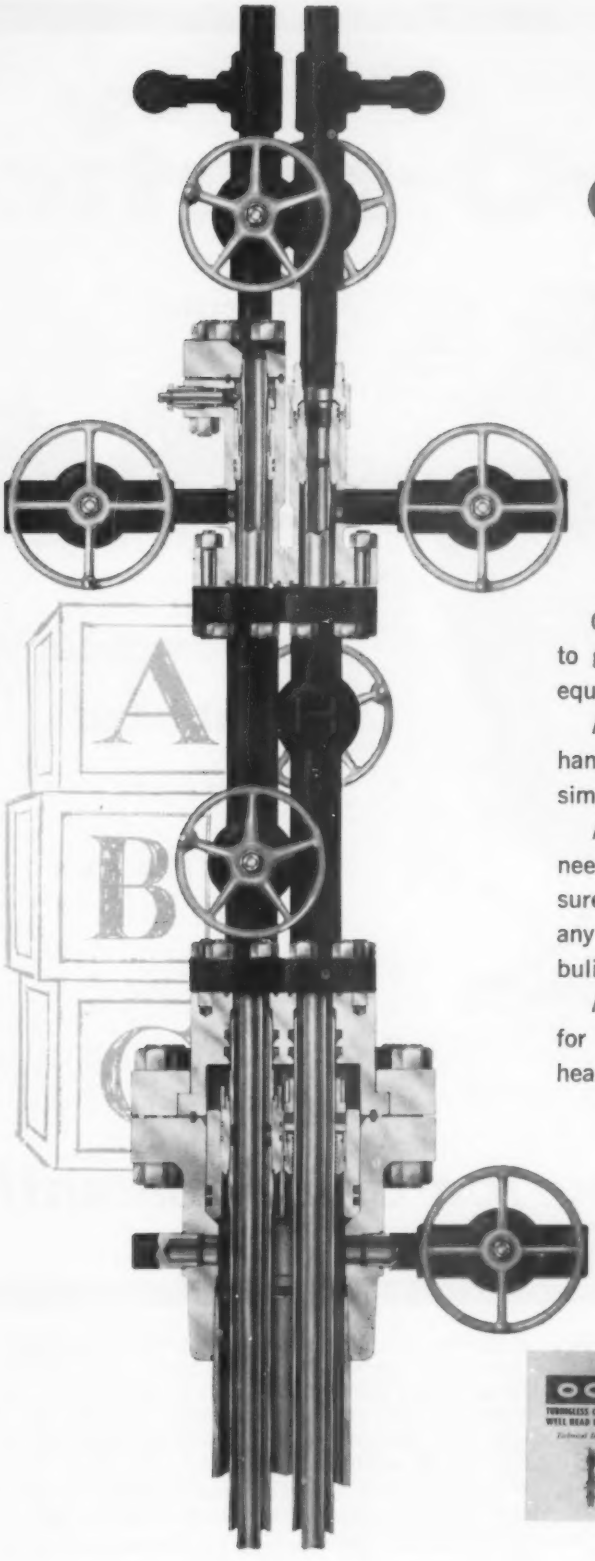
The peak load on the upstroke can be determined by multiplying the static upstroke load by the appropriate impulse factor. This upstroke load is shown in Fig. 1 as the "peak polished rod load."

Dynamic effects also affect the downstroke load but lower the minimum load in the first half of the downstroke. It is necessary to counterbalance a portion of the well load to minimize the peak torque on the gear reducer of a pumping unit and to keep the peak torque equal on both the upstroke and downstroke. A theoretical counterbalance in the static condition gives equal net loads to the gear reducer on both upstroke and downstroke, i.e. the weight of the sucker rod plus half the fluid weight.

At higher speeds and longer strokes, the theoretical counterbalance must be multiplied by a "counterbalance factor" (CF) to determine the required counterbalance. Dynamic factors that influence polish rod loads also influence effectiveness of counterbalance. When counterweight was adjusted to equalize peak loads on the gear reducer, it was found that less counterweight was needed than was indicated by static calculations. The amount needed decreased with increase of stroke length or speed.

Corrections may be highly important when rod string weight is high in proportion to weight of the oil, as in deep wells with small bore pumps. The counterbalance factor, as determined experimentally, is shown as "CF" in Table 1 for different combinations of stroke lengths and frequency.

The net upstroke load to the cranks is the uncounterbalanced portion of the polished rod



Tubingless Completions are simpler with O·C·T equipment

O·C·T tubingless completion equipment is designed to give you simplicity and flexibility that simplify your equipment problems.

A complete line of interchangeable slip and threaded hangers lets you suspend from one to eight tubing strings, simply by changing hangers.

A variety of casing heads for these hangers meets your needs for single or multiple completions, at working pressures up to 10,000 psi. Master Bushings allow assembling any desired multiple completion and permit running turbulizers, centralizers or other related downhole equipment.

A new type M (for macaroni) tubing head is supplied for hanging 1½-inch and smaller tubing strings. These heads can be furnished with either flanged or threaded connections on top and bottom. Crescent flanges, tri-flanges, and quadri-flanges are available.

If you want to use an economical tubingless completion on your next well, talk with your nearby O·C·T representative. He can show you the latest in tubingless completion equipment.

Write for the helpful free booklet, "O·C·T Tubingless Completion Well Head Equipment," which discusses requirements for tubingless completion equipment.

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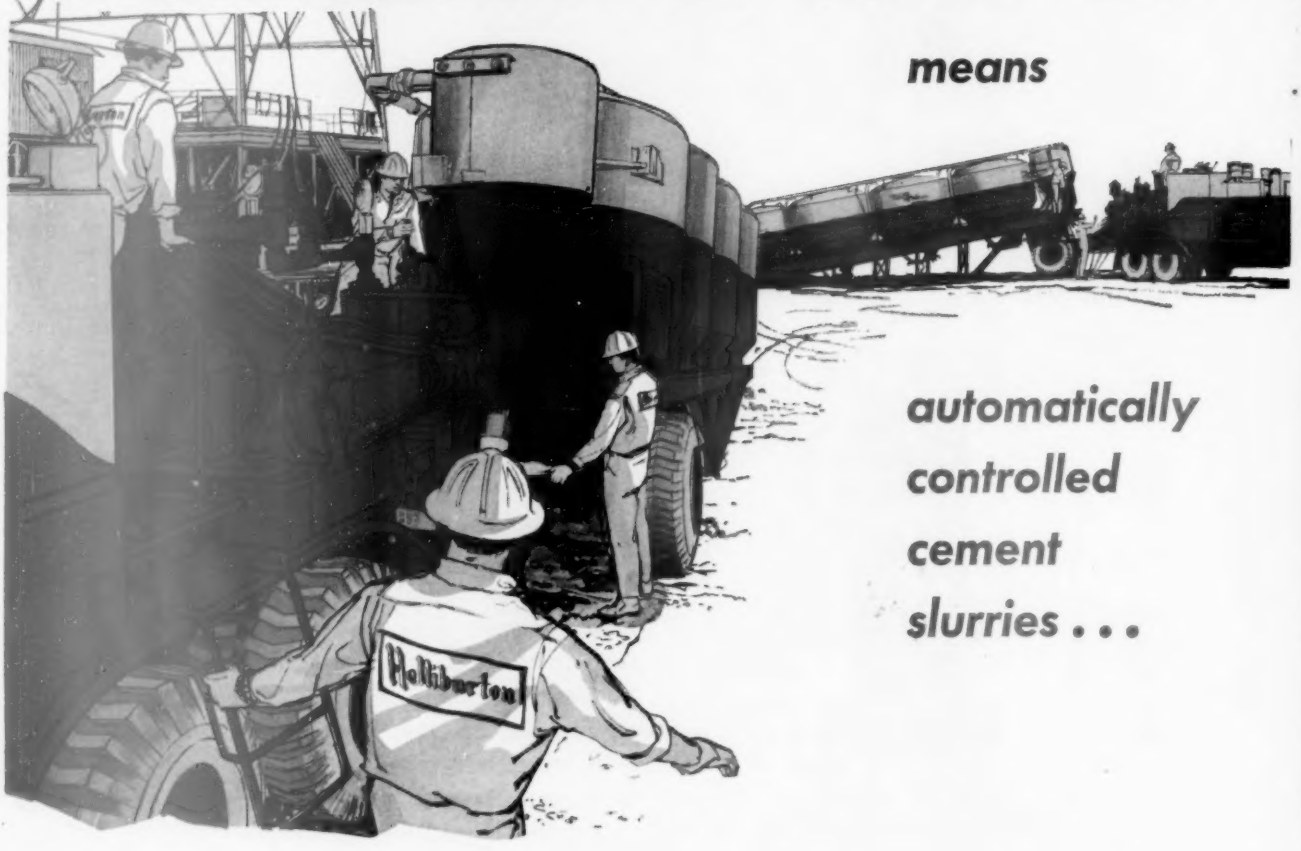
Cement-O-matic



means

automatically controlled cement slurries . . .

a new Halliburton development!

"CEMENT-O-MATIC" is Halliburton's new automated slurry mixing system for primary and remedial cementing. It is designed to:

- AUTOMATICALLY MAINTAIN a constant preselected slurry weight.
- CONTINUOUSLY MEASURE the weight of cement slurry and indicate the flow rate.
- INSTANTLY INDICATE the total flow at any point during the cementing job.

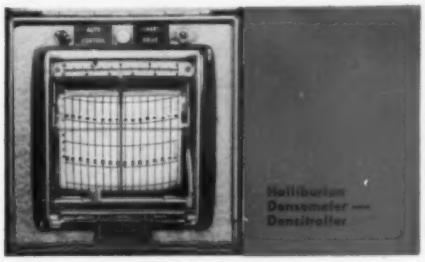
The new automatic instruments which make "Cement-O-matic" possible are the Densometer, Densitroller, Flow Meter, and Flow Analyzer — all developments of Halliburton research. The "Cement-O-matic" slurry mixing system represents another Halliburton achievement in the search for *better* cementing services and techniques . . . a more uniform cement slurry can now be placed which helps eliminate weak "troublesome" spots in the cement column . . . the position of cementing plugs can be more easily determined during a cementing operation and the cement location can be more accurately checked during plug back or squeeze operations.

Revolutionary improvements such as the Cement Jet Mixer, developed by Halliburton nearly 40 years ago — Bulk Cementing, special cements, cement additives and Pneumatic Bulk Cement Handling Equipment, pioneered by Halliburton — and now "Cement-O-matic" . . . these are but a few examples of how Halliburton applied research works for you to increase the efficiency of your service dollar.

1 monitors the slurry density

A slurry sample is continuously passed through and measured by the DENSOMETER. Within ten seconds after *any* change in density is noted by this sensitive instrument, pneumatic pulses reflecting the change are signalled to the Densitroller, which then acts to return the slurry to the pre-selected weight. The Densometer/Densitroller team can maintain a density accurate to within ± 0.1 pound per gallon throughout its entire 6 to 21 pounds per gallon range.

2 automatically controls slurry density



The new Halliburton DENSITROLLER is the controlling instrument which maintains the cement slurry weight desired. This weight is pre-set on the Densitroller by the operator. The instrument then controls the system to maintain this pre-selected weight automatically, regardless of changes in flow rate and/or pressure. With the Densometer and Densitroller both in use, the pre-set density can be changed by the operator at any desired point during the job by resetting the density selector. The slurry weight is continuously recorded on a strip chart.

3 measures slurry flow rate

The Halliburton Turbine FLOW METER and FLOW ANALYZER makes possible the determination of the cementing plug's position at any time during the cementing job. Also, in plug back or squeeze operations, the cement position can be more quickly and easily calculated at any time. These calculations are based on the continuous gpm flow rate and cumulative total flow readings displayed by the Flow Analyzer. This data is obtained by the Turbine Flow Meter which is installed directly in the slurry flow line, and continuously transmits the data to the Flow Analyzer.

Ask your Halliburton man about the availability of "Cement-O-matic," the new automated cement slurry mixing system.

CEMENTING SERVICES

275 Service Centers ...just minutes away from your well!

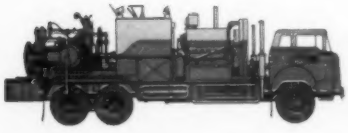


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TABLE 1. Impulse and Counterbalance Factors.

Stroke length (In.)		Strokes per minute									
		8	10	12	14	15	16	18	20	25	30
	IF	1.05	1.06	1.06	1.06	1.07	1.07	1.08	1.08	1.10	1.12
16	CF	.996	.994	.991	.988	.987	.985	.980	.976	.965	.950
	IF	1.06	1.06	1.06	1.07	1.07	1.07	1.08	1.09	1.11	1.14
20	CF	.995	.992	.988	.985	.983	.981	.976	.971	.957	.940
	IF	1.06	1.06	1.07	1.08	1.08	1.08	1.09	1.10	1.13	1.17
24	CF	.994	.991	.987	.983	.980	.977	.972	.967	.949	.929
	IF	1.06	1.07	1.08	1.08	1.09	1.09	1.10	1.11	1.15	1.20
28	CF	.993	.990	.986	.981	.977	.974	.967	.961	.941	.918
	IF	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.16	1.22
30	CF	.992	.989	.985	.979	.976	.972	.965	.958	.937	.913
	IF	1.06	1.07	1.09	1.10	1.10	1.11	1.12	1.14	1.18	1.26
34	CF	.992	.987	.981	.976	.973	.969	.961	.954	.930	.904
	IF	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.20	1.28
36	CF	.991	.986	.980	.974	.971	.967	.959	.951	.927	.899
	IF	1.07	1.08	1.10	1.12	1.12	1.13	1.15	1.17	1.24	1.35
42	CF	.990	.984	.977	.970	.966	.962	.953	.944	.917	.885
	IF	1.07	1.09	1.11	1.13	1.14	1.15	1.17	1.20	1.28	1.42
48	CF	.988	.981	.974	.967	.963	.958	.947	.936	.907	.872
	IF	1.08	1.09	1.12	1.14	1.15	1.16	1.20	1.23	1.34	1.53
54	CF	.986	.978	.970	.962	.958	.952	.941	.930	.899	.860
	IF	1.09	1.11	1.13	1.16	1.17	1.19	1.23	1.28	1.46	1.75
64	CF	.984	.975	.956	.957	.952	.945	.932	.918	.881	.841
	IF	1.10	1.12	1.15	1.18	1.20	1.23	1.29	1.34	1.60	.....
74	CF	.982	.972	.961	.950	.945	.938	.922	.907	.865	.....
	IF	1.10	1.14	1.18	1.22	1.24	1.28	1.36	1.42	.....	.....
86	CF	.978	.968	.955	.942	.935	.927	.911	.895	.....	.....
	IF	1.14	1.18	1.26	1.35	1.39	1.48	1.67	1.85	.....	.....
120	CF	.971	.958	.940	.923	.914	.903	.882	.861	.....	.....

load, i.e. peak polished rod load minus required counterbalance. Approximate net gear torque is determined by multiplying the uncounterbalanced load by one-half of the stroke length.

Equations Simplified

Equations were developed to find peak polished rod load, required counterbalance, and expected gear torque, using the following terms:

PRL = Peak polished rod load, lb
CB = Maximum counterbalance, lb
IF = Impulse factor
CF = Counterbalance factor
T = Peak gear torque, in.-lb
R = Rod weight in air, lb
FL = Net downward force (lb) produced by pressure of the fluid column being lifted, acting on exposed surfaces of sucker rods and bottom hole pump
STR = Stroke length (in.) required

$$PRL = R \times FL \times IF \quad \text{Eq. 1}$$
$$CB = R \times \tfrac{1}{2} FL \times CF \quad \text{Eq. 2}$$
$$T = (PRL = CB) \times \tfrac{1}{2} \text{ Str.} \quad \text{Eq. 3}$$

Load Factors Combined

In selecting pumping units, most operators try to be conservative and provide ample capacity for the most severe pumping conditions of a well. This means that the fluid level is at the pump and fluid specific gravity is 1.0. Values for the following conditions are required in the above equations to calculate pumping unit requirements: (1) maximum expected pumping depth; (2) maximum expected plunger size; (3) rod string size; (4) maximum expected unit strokes per minute (SPM); and (5) maximum stroke length necessary to pump daily production with above plunger size and unit SPM.

If well loads are to be calculated for known conditions, the following additional factors should be considered: (6) specific gravity of oil; (7) specific gravity of water; (8) percent water; and (9) actual net lift of fluid.

These factors affect only the fluid in Eq. 1 and 2. They tend to decrease fluid loads except when specific gravity of the fluid is greater than 1.0. Table 2 gives the calculated loads for various combinations of plunger diameters and rod strings per 1000 ft of well depth. These loads are based on a fluid specific gravity of 1.0 and with a net fluid lift from the top of the pump plunger (no bottom-hole pressure).

Tapered rod strings are proportioned so that the stresses are equal at the top section of each size rod (this is the theoretical maximum stress in the rod string). Rod weight per 1000 ft and fluid weight per 1000 ft in Eq. 1 can be combined to give a "static polished rod load per 1000 ft" of well depth. Likewise, in Eq. 2, rod weight per 1000 ft and one-half of the fluid weight per 1000 ft can be combined to give the "static counterbalance required per 1000 ft" of well depth. The following equations apply to Table 2:

PRL = (polished rod dead load/1000 ft) x depth (ft) x IF ..... Eq. 4
CB = (counterbalance required/1000 ft) x depth (ft) x CF ..... Eq. 5

NEW from Wilson Supply Fishing Tool Division

2¼" O. D. Flush Joint Washpipe

The Engineering Research and Development group at Wilson Supply Fishing Tool Division has come up with the answer for operations inside tubingless completions and small diameter pipe with its new 2¼" O.D. Flush Joint Washpipe. And this rental pipe is available with either right-hand or left-hand threads. Left-hand threads make it possible to washover, back-off and retrieve — all in one operation.

All the handling tools for the right- and left-hand strings are available, too . . . Taper Taps, Subs, Lift Plugs, Safety Clamps, Rotary Shoes and the Wilson PS-70 Power Swivel can provide the rotary power for this new 2¼" Washpipe.

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TABLE 2. Rod String Loads and Counterbalance (Lb).

Pump plunger diameter (in.)	*Bbl per day	*HP per 1000 ft	1 in. Polished rod dead load per 1000 ft	1 in. Counterbalance required per 1000 ft	% 1 in. rods	1 in. & 7/8 in. Polished rod dead load per 1000 ft	1 in. & 7/8 in. Counterbalance required per 1000 ft	% 1 in. rods	% 7/8 in. rods	1 in., 7/8 in. & 3/4 in. Polished rod dead load per 1000 ft	1 in., 7/8 in. & 3/4 in. Counterbalance required per 1000 ft	7/8 in. Polished rod dead load per 1000 ft	7/8 in. Counterbalance required per 1000 ft	% 7/8 in. rods	7/8 in. & 3/4 in. Polished rod dead load per 1000 ft	7/8 in. & 3/4 in. Counterbalance required per 1000 ft
1	11.6	0.086	2888	2888	19.8	2362	2330	17.1	20.4	2051	1996	2241	2201	23.7	1875	1807
1 1/16	13.2	0.097	2932	2910	20.2	2409	2355	17.5	20.9	2102	2026	2285	2223	24.3	1920	1832
1 1/4	18.2	0.134	3079	2984	21.5	2564	2437	19.0	22.6	2273	2125	2432	2297	26.3	2077	1916
1 1/2	26.3	0.193	3313	3101	23.5	2812	2569	21.2	25.4	2546	2284	2666	2414	29.4	2326	2049
1 3/4	35.7	0.264	3590	3239	26.0	3104	2724	23.9	28.6	2869	2471	2943	2552	33.1	2621	2207
2	46.6	0.343	3908	3398	28.8	3441	2902	27.0	32.3	3239	2686	3261	2711	37.4	2960	2388
2 1/4	59.0	0.435	4268	3578	32.0	3821	3104	30.5	36.5	3660	2931	3621	2891	42.3	3343	2593
2 1/2	72.9	0.537	4678	3783	35.6	4254	3333	34.5	41.1	4134	3206	4031	3096	47.7	3774	2824
2 3/4	88.2	0.650	5118	4003	39.5	4720	3580	38.8	46.3	4651	3506	4471	3316	53.7	4249	3077
3 1/4	123.0	0.907	6139	4509	48.6	5803	4155	—	—	—	—	5485	3820	67.8	5330	3654
3 3/4	164.0	1.210	7328	5108	59.1	7055	4819	—	—	—	—	6681	4421	83.5	6602	4336
4 3/4	263.0	1.940	10218	6553	84.7	10110	6439	—	—	—	—	9571	5866	—	—	—

Pump plunger diameter (in.)	*Bbl per day	*HP per 1000 ft	3/4 in. Polished rod dead load per 1000 ft	3/4 in. Counterbalance required per 1000 ft	% 3/4 in. rods	3/4 in. & 5/8 in. Polished rod dead load per 1000 ft	3/4 in. & 5/8 in. Counterbalance required per 1000 ft	5/8 in. Polished rod dead load per 1000 ft	5/8 in. Counterbalance required per 1000 ft	% 5/8 in. rods	5/8 in. & 1/2 in. Polished rod dead load per 1000 ft	5/8 in. & 1/2 in. Counterbalance required per 1000 ft	1/2 in. Polished rod dead load per 1000 ft	1/2 in. Counterbalance required per 1000 ft
1	11.6	0.086	1759	1685	28.8	1464	1368	1344	1241	36.3	1095	976	955	828
1 1/16	13.2	0.097	1803	1707	29.8	1511	1395	1388	1263	38.0	1145	1014	999	850
1 1/4	18.2	0.134	1950	1780	32.9	1672	1482	1535	1336	43.6	1322	1105	1147	924
1 1/2	26.3	0.193	2184	1897	37.9	1926	1621	1769	1453	52.5	1583	1255	1381	1041
1 3/4	35.7	0.264	2461	2036	43.8	2229	1786	2047	1592	63.0	1900	1437	1657	1179
2	46.6	0.343	2780	2195	50.7	2576	1977	2367	1752	75.1	2268	1647	1980	1340
2 1/4	59.0	0.435	3140	2375	58.4	2968	2191	2727	1932	88.8	2681	1883	2340	1520
2 1/2	72.9	0.537	3540	2575	67.1	3404	2429	3127	2132	—	—	—	2740	1720
2 3/4	88.2	0.650	3990	2800	76.6	3894	2697	3577	2357	—	—	—	3190	1945
3 1/4	123.0	0.907	5005	3305	—	—	—	4594	2864	—	—	—	4210	2455
3 3/4	164.0	1.210	6200	3905	—	—	—	5787	3462	—	—	—	—	—
4 3/4	263.0	1.940	9090	5350	—	—	—	8677	4907	—	—	—	—	—

TABLE 3. Dead Weight of Rods and Fluid.

Rod size (In.)	Wt. of rods per 1000 ft (Lb)	Weight of Fluid Lb per 100 Ft — PUMP PLUNGER SIZE IN. 1	1 1/16	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3 3/4	4 3/4
1/2	700	255	299	447	681	957	1280	1640	2040	2490	4700	7590
5/8	1134	207	251	398	632	910	1230	1590	1990	2440	4650	7540
3/4	1605	149	193	340	574	851	1170	1530	1930	2380	4590	7480
7/8	2155	80	124	271	505	782	1100	1460	1870	2310	4520	7410
1	2879	0	44	191	425	702	1020	1380	1790	2230	4440	7330

TABLE 4. Gravity Conversion.

API	10	15	20	25	30	35	40	45	50	55	60	65	70
SP GR	1.000	.966	.934	.904	.876	.850	.825	.802	.780	.759	.739	.720	.706

Sample Calculations

An example of a well load calculation can be made with Eq. 3, 4 and 5, making the following assumptions: (1) pumping depth = 4000 ft; (2) plunger size = 1½ in.; (3) rod string size = ¾ in.; (4) unit SPM = 16; (5) stroke length = 42 in.

Table 2 shows for 1½-in. plunger diameter and ¾-in. sucker rods: polished rod load/1000 ft = 2184 lb; and counterbalance required/1000 ft = 1897 lb.

Table 1 shows for 16 SPM and 42-in. stroke: impulse factor (IF) = 1.13; and counterbalance factor (CF) = 0.962.

Peak polished rod load, PRL
= (2184/1000) 4000 x 1.13 = 9872 lb. (Eq. 4).

Required counterbalance, CB
= (1897/1000) 4000 x 0.962 = 7300 lb (Eq. 5).

Expected peak gear torque, T
= (9872-7300) 42/2 = 54,012 in. lb (Eq. 3).

With these as minimum specifications, a

Better Production Tools Through Research

OTIS Equipment NEWS

Volume III, Number 5 Otis Engineering Corporation • Dallas *Production Equipment and Services*

Self-Retracting Hold-Down Uses Reservoir and/or Treating Pressure To Help Anchor New Hookwall Packer

By-Pass Ports Are Located Above Hold-Down to Minimize Equalization Problem

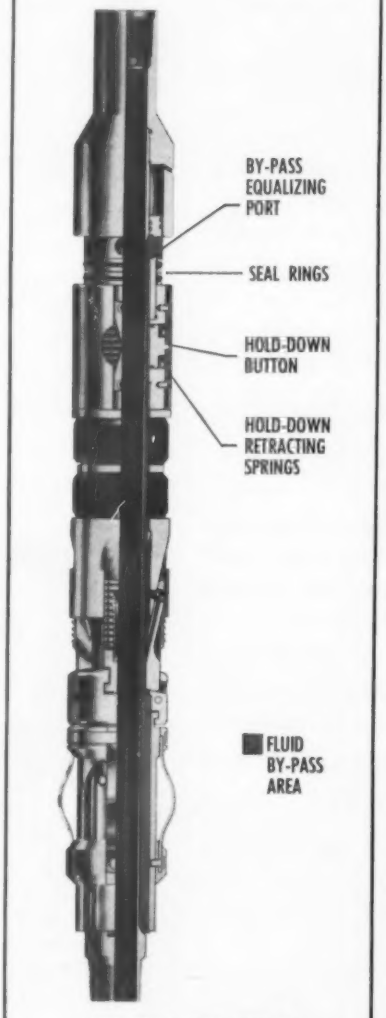
DALLAS — How better can you anchor a packer in a well than to utilize the pressure that is trying to force it up the hole to help lock it in position? That's the design principle employed by the hydraulic hold-down of the new Type RSMA Otis Packer.

Type RSMA Otis Packers are a series of retrievable, tubing set packers rated to 7,500 or 10,000 p.s.i. at 300° F. They combine several new and unique features with many of the time-tested advantages of other Otis Packers to provide the industry a more reliable "hookwall" packer. The tool has a standard J-Latch arrangement with provisions to automatically relock the packer in the running position while in the hole for resetting.

Design Principles of Hydraulic Hold-Down

The Type RSMA Otis Packer uses a new and somewhat unique hold-down mechanism. The principles employed in the design of this mechanism are as follows: In the running position the hold-down buttons located just above the packer's resilient elements are held retracted by individual retracting springs and isolated from the fluid pressure in the tubing. Once the packer is set, the hold-down buttons are exposed to pressure below the packer through an equalizing bypass area between the packer's inner mandrel and outer body which is sealed at the top. This permits the pressure from below the packer, which is trying to force it up the hole, to expand the hold-down buttons. The greater the pressure from below the packer, the greater the force exerted on the hold-down buttons. The combined casing contact area of the hydraulic hold-down buttons on the 5½" model totals 16 square inches, an area considerably greater than available with a tubing-type hold-down.

Picking up on the tubing to release the packer when retrieving opens the by-pass area to permit equalization



TYPE RSMA OTIS PACKER
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across the packer. Once pressure has been equalized, the leaf-type retracting springs on each of the hold-down buttons serve to retract the hold-down.

Advantages of RSMA Design Principles

The Type RSMA Otis Packer is designed to be run in the well on tubing and set by one-third turn of the tubing at the packer, setting down tubing weight to expand the resilient elements. It has a full-opening bore to pass standard size wire line tools, perforating guns, pressure bombs, etc. The tool is available with a choice of resilient packer elements. The 5½-inch model is designed to set in a wider range of casing weights (13 to 20 lbs.), without modification, than any other retrievable tubing set packer of this type and yet the resilient packer elements have a smaller outside diameter than the O.D. of the smallest metal part of the packer's body. This feature is designed to protect the resilient elements from junk, etc. when running, retrieving and resetting the packer.

The Type RSMA Otis Packer is another example of the knowledge and ingenuity of the packer design section of the Otis Engineering Department. Although advanced in concept, this new tool utilizes operating principles tested by years of performance in the field. When you combine the advantages of new Otis production tools like the Type RSMA with the experience and knowledge of your local Otis Packer Specialist, you will find you are getting the finest in service and performance. For more information on the Type RSMA Otis Packer or for information on other Otis field-proven packers, call the Otis office nearest you or write Otis, Dept. E-5, P. O. Box 35206, Dallas 35, Texas. You'll find experienced service specialists ready to help you . . anxious to serve you . . with the widest variety of field-tested production tools available today.

standard sized pumping unit can be selected from a manufacturer's selection chart.

Tapered String Example

Well loads sometimes have to be checked after the pumping unit is operating. The most accurate method generally available employs a dynamometer survey and torque factors of the pumping unit. However, calculation often must be made from known well conditions without a dynamometer. For example, the following pumping conditions may be used: (1) pumping depth = 6000 ft; (2) plunger size = 1½-in.; (3) rod string size = ⅞-in. (1800 ft) and ¾-in. (4200 ft); (4) unit SPM = 14; (5) stroke length = 64 in.; (6) spec. grav. of oil = 40 API; (7) spec. grav. of water = 1.2 (brine); (8) percent water = 20%; and (9) net lift of fluid = 5000 ft.

When rod loads and fluid loads are not covered by Table 2, Tables 3 and 4 can be used. Table 3 gives the dry weight of rods and the head of fluid (1.0 spec. grav.) acting on the net plunger area (as weight per 1000 ft). For other specific gravities, fluid weights per 1000 ft must be multiplied by the correct value. Table 4 converts API gravity to specific gravity. For tapered strings of rods, weights are separately calculated for the lengths of each rod size and totaled.

Using the above figures in Table 2, the IF and CF corresponding to 14 SPM and 64-in. stroke are: IF = 1.16 and CF = 0.957.

Rod weights are found in Table 3: wt. of ⅞-in. rods = 2161 lb/1000 ft, and wt. of ¾-in. rods = 1610 lb/1000 ft.

Fluid weights are given in Table 3 for each rod size and 1½-in. plunger: wt. of fluid with ⅞-in. rods = 505 lb/1000 ft, and wt. of fluid with ¾-in. rods = 574 lb/1000 ft.

Specific gravity of 40 API oil (Table 4) = 0.825 and specific gravity of the water-oil mixture = 80% of 0.825 plus 20% of 1.2 = 0.90.

Total weight of ⅞-in. rods = 2161 x 1.8 = 3890 lb

Total weight of ¾-in. rods = 1610 x 4.2 = 6762 lb

Total weight of rods = 10,652 lb

Weight of fluid with ⅞-in. rods = 0.90 x 505 x 1.8 = 818 lb

Weight of fluid with ¾-in. rods = 0.90 x 574 x 3.2* = 1653 lb

Total weight of fluid = 2471 lb

*Fluid column is 3200 ft (5000 - 1800) since with a net lift of 5000 ft the fluid level is 1000 ft above the pump plunger.

Eq. 1, 2 and 3 give the following figures with these calculated weights:

$$PRL = (10{,}652 + 2471) \times 1.16 = 15{,}223 \text{ lb}$$

$$CB = (10{,}652 + 2471/2) \times 0.957 = 11{,}377 \text{ lb}$$

$$T = (15{,}223 - 11{,}377) \times 64/2 = 123{,}072 \text{ in.-lb}$$

Method Has Wide Use

Although many methods are used for sizing beam pumping units and calculating well loads, this method was proved by wide field experience. Empirical impulse and counterbalance factors were determined from careful analysis of many actual pumping conditions. These factors adjust calculated static well loads to actual well loads as expected from a combination of stroke length and strokes per minute. These loads are reasonable for the average pumping well conditions.

Impulse and counterbalance factors in Table 1 apply to any well, whether single, dual or triple completion, so long as the static rod and fluid loads can be determined. If pumping wells have severe flow restrictions, such as pumping through "back pressure" valves and hollow sucker rods, the fluid loads should be determined by using basic hydraulics. Special consideration should be given to wells with fluid specific gravity larger than 1.0 (i.e. waterflood wells producing large amounts of salt water).

About the Author

A. J. Otte started with National Supply shortly after he was graduated in 1950 with a BS in Management Engineering from Texas A&M College. He was appointed store manager at Sundown, Texas, the following year, and in 1953 made store manager at Hobbs, New Mexico. In 1957, he was transferred to National's Gainesville, Texas, plant as a sales engineer, and to the southwest divison headquarters in Dallas in 1960 as a production equipment engineer. At Texas A&M Otte was elected to the Scholarship Honor Society. He is also a member of Tau Beta Phi, Phi Kappa Pi and the Society of Petroleum Engineers of AIME.

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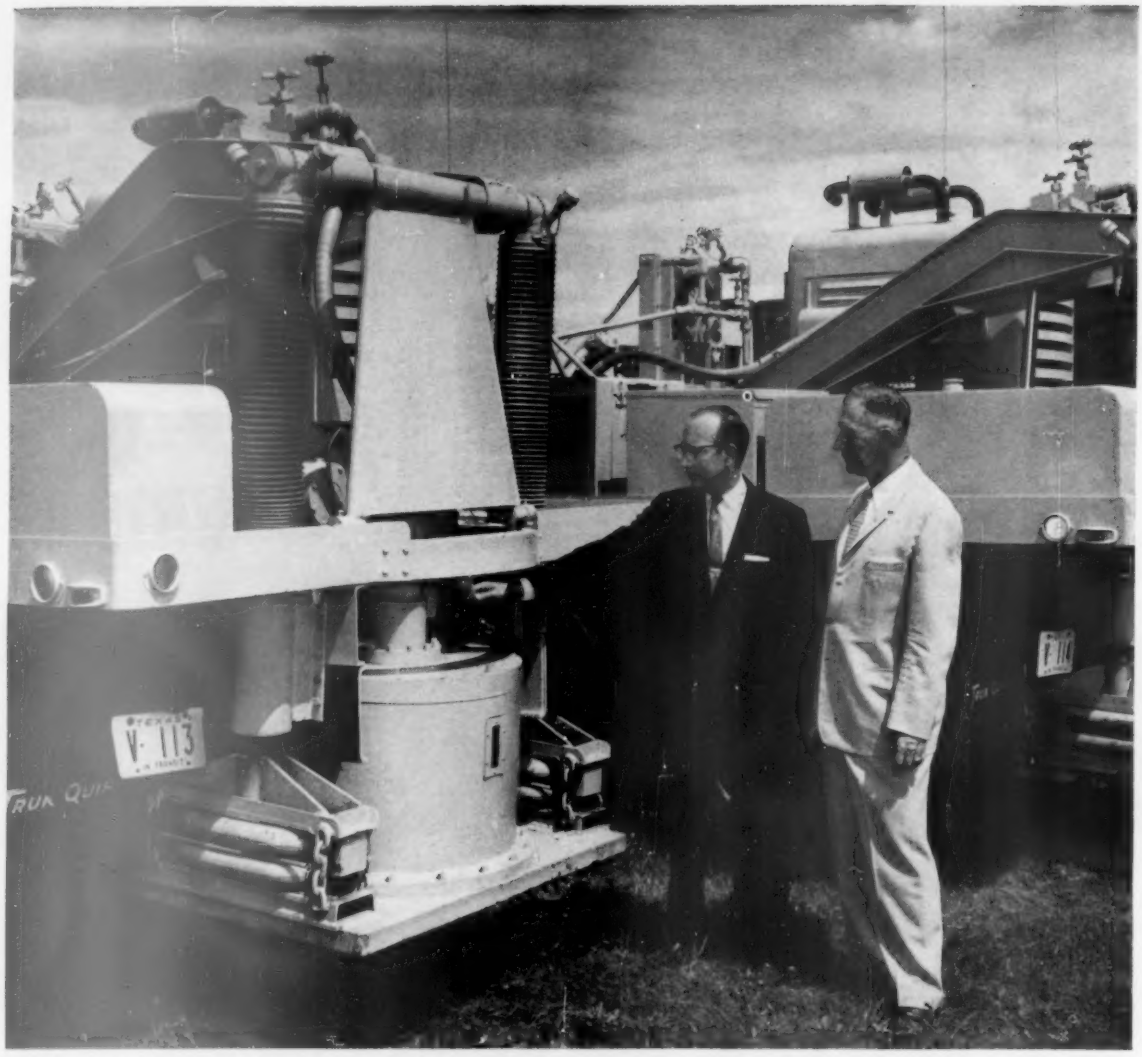

Making a final check of a Vibroseis unit before its shipment overseas for prospecting in Libya are W. O. Heap, left, senior research engineer, and Dr. A. J. Barthelmes, executive vice president of Seismograph Service Corp.'s foreign operations. More than $400,000 worth of equipment has been shipped to Libya under a contract with Oasis Oil Co. of Libya, Inc.

Seismic Vibrators At Work in Libya

Twelve trucks and seven trailers loaded with specialized seismograph equipment that obtains records without drilling, explosive and hole-loading are at work in Libya for the first time.

Difficult drilling and recording conditions in many areas of the country prompted selection of the equipment by Oasis Oil Co. of Libya, Inc. known as Vibroseis, the system produces seismic waves from electronically controlled servo-hydraulic vibrators mounted on the rear of the trucks.

The system was developed by Continental Oil Co. research and exploration personnel and licensed to Seismograph Service Corp.

The equipment sent to Libya includes three of the truck-mounted vibrators, plus a recording truck and support equipment and vehicles. Working in unison, the truck-mounted vibrators can be moved across the areas to be explored, generating controlled, synchronized seismic waves upon command through radio signals transmitted from a magnetic tape in the recording truck. ■

the case for using a SWACO D-GASSER on most of the wells you drill

Many operators and drilling contractors don't realize how D-Gassers can help them reduce the over-all cost of wells. By removing entrained gas and air from drilling mud after each circulation, the D-Gasser permits improved control of mud characteristics. As a result, many operators can profit from some of the following savings:

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SAVES LOST CIRCULATION MATERIALS. Since the D-Gasser often makes it possible to continue drilling while the well is "kicking", lighter mud can be used and lost circulation problems may be held to a minimum.

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SAVES WELLS. Many high pressure exploratory wells have actually been saved by the D-Gasser. Costly blowouts, fires and lost holes have been avoided. For full information on how the D-Gasser can help you, contact your nearest SWACO representative or write us direct.

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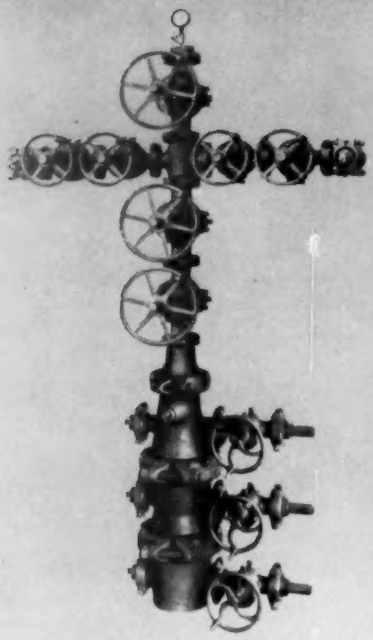

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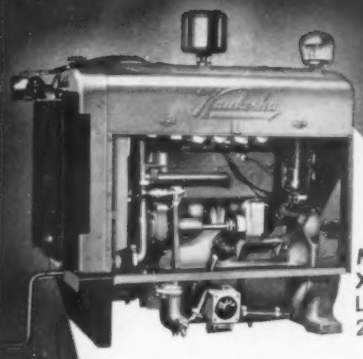

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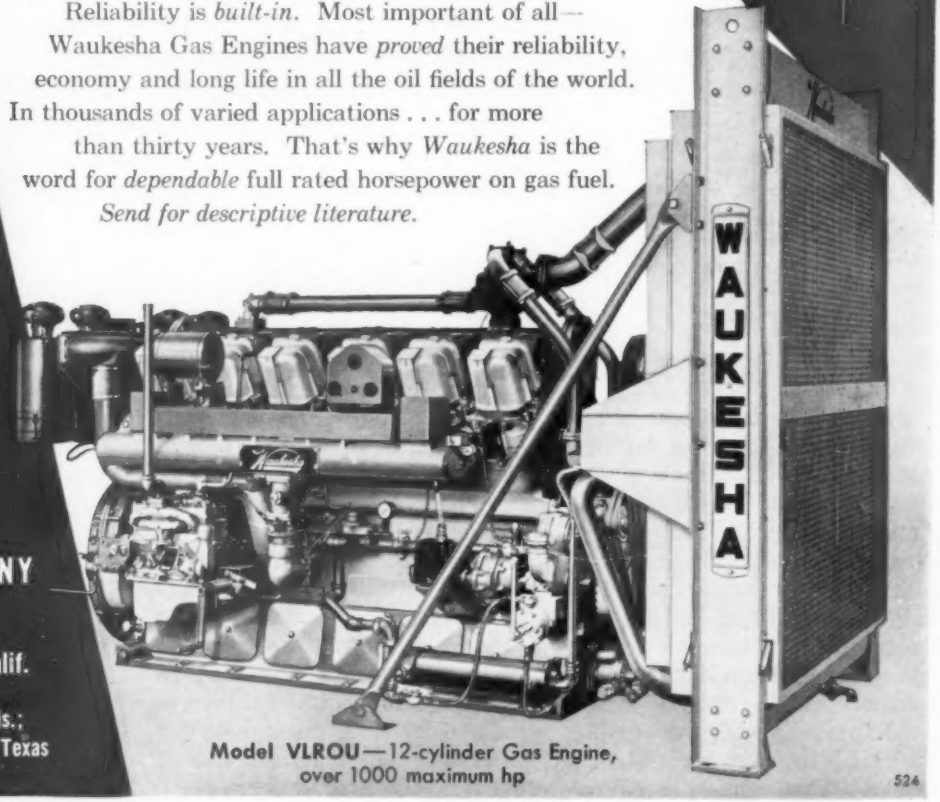

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Changing Completion Practices for the Appalachian

Advent of the rotary rig and rotary methods in the historically cable tool Appalachian area has produced a new set of well completion problems and practices.

Wildcatting is more prevalent.

More acreage is under lease by major and independent companies well founded in rotary methods.

Logging is a problem in rotary mud-drilled wells there.

Mud has plastered off productive horizons, particularly gas, to decrease well productivity.

Air and gas drilling, for these reasons and others, is finding wide acceptance in the Appalachian region. The technique offers some advantages of faster rotary methods, permits drilling a dry hole if required, and allows the hole to be mudded up to control high-pressure zones or to log.

Well completion techniques in the Appalachian region are of such importance that panelists gathered to discuss it at the recent eastern district meeting of the American Petroleum Institute's Division of Production.

Moderated by D. L. Barger, New York State Natural Gas Co., the panel included: George O. Scott, Peoples Natural Gas Co., who discussed "Setting on Top Vs. Setting Through Completions"; H. J. Magner, Delta Drilling Co., who spoke on "Drilling and Completing With Fluids Lighter Than Liquids"; and Andy Reid, Baroid Div., The National Lead Co., who presented his views on "Effect of Drilling Fluids on Production."

Setting Casing Above or Through Pay Zones

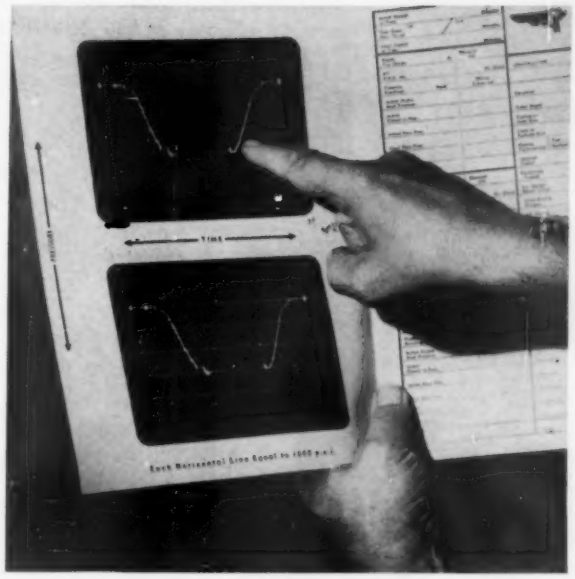
by George O. Scott

Benefits and drawbacks of setting casing on top of or through the producing formation are being discussed throughout the Appalachian area. The controversy is especially keen among those operators whose objective is the Oriskany formation. Penetrating the stratigraphic section and setting on top has been the common practice.

All Oriskany wells were drilled with cable tools prior to the early 1950's. When these wells encountered high pressures and high volumes in an empty hole in the Oriskany without adequate protection, the operation often led to disaster.

Advent of the rotary allowed greater flexibility. Any Oriskany well could be drilled-in without pipe in the hole. Unfortunately, early attempts to drill through the Oriskany with fluid were marred by fluid damage to the sand face and sustained loss of deliverability.

These earlier experiences caused a reluctance to consider drilling through with mud for fear of mudding off permeability. Shallow zones (pay horizons above the Oriskany) are still drilled by cable tools where the technique in most instances has been to drill through and examine the section, then set pipe. High volumes occasionally have been encountered, but pressure ranges are relatively low and a well can



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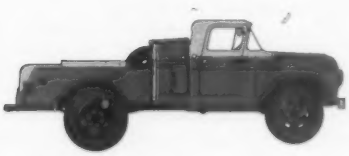

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be brought safely under control.

In the Oriskany section, both techniques are being used: set-through and set-on-top.

Where there are two techniques being employed, there must be drawbacks and advantages to each.

Set-on-Top—Drill-Through

In the case of set-on-top, you have effective continuous drillstem tests in the pay section penetrated. In the case of drill-through, you must log or take a drillstem test of the section.

In set-on-top, completion logs of the empty hole are usually of poor quantitative value. Drilling through the pay with a mud-filled hole results in logs of good quantitative and qualitative value. In setting on top, there is no damage to the sand face. In the case of drilling through, damage to the sand face may be slight to severe.

In the case of set-on-top, pipe must be set to evaluate the producing interval to be penetrated below the casing. In drilling through, the pay zone can be evaluated without pipe.

In case of set-on-top, it is impossible to pinpoint a section to be fractured. The entire section must be exposed to fracture treatment. In the drill-through case, zones which are most likely to produce can be isolated and fractured.

Recompletion of a set-on-top is very difficult, whereas a drill-through recompletion is relatively simple.

Drilling Through The Oriskany

An Oriskany well can be drilled with ordinary tools in most cases. Surface pipe can be set and the hole can be air-drilled. Casing can be set on top of the objective.

Air drilling's economic advantages are obvious. In almost all instances, every effort is made to assure that the hole will be air-drilled through the objective.

If water is encountered below the surface pipe, foam is used. But, in penetrating the Marcello section below the Tulley, use of foam could prove disasterous, so this section is drilled with mud rather than with foam.

Assume that the hole is air-drilled through the objective and the decision made to mud-up and drill through the productive zone. Time required to mud up and properly circulate the hole before proceeding might be equivalent to the WOC time should the well be air-drilled or gas-drilled with casing set on top. Primary cost factor is that of the mud only.

Drilling ahead with mud through this section takes approximately four to five times as long as drilling through with air or gas. In some wells with long trip sections, this can amount to four days.

After drilling through, the well is logged, pipe is run and cemented and the rig is released. Removal of the cement by displacement with water can be accomplished easily by moving in a portable bailing machine.

Correct interpretation of down-hole logs in this case is of primary importance. Drillstem tests of the section should be taken. Completion of the well then depends upon interpretation of the logs. After removal of cement, the well is perforated and, if necessary, fractured.

With pipe set through the objective, each potential zone or zones can be treated individually or in a single treatment applied to all zones. The operator has a large degree of flexibility regarding the fracture treatment to be employed.

Consider a well with pipe set on top of the objective and drilled through dry. When the casing point is reached, the pipe is run dry, fluid is circulated and pipe is cemented. After a WOC time of 48 hr, displacement water is removed, the hole is dried and drilling is resumed. Gas is used as a circulating medium and, depending upon the section to be

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drilled, ½ to 2 million cu ft of gas is used to drill in. Any gas or liquid encountered during the drilling-in will be detected and flow tests can be taken constantly during drilling.

After drilling ceases and production is obtained, logs are run to determine what further steps will be taken. Present empty-hole logs, unfortunately, do not have the qualitative value necessary for complete reliance. But, certainly, they add to the information already known.

If the decision is to treat the well hydraulically, it is necessary to determine how much of the section is to be treated. The well can be plugged back with the hole section left open. Little variation in treatment is available.

If a commercial producer is obtained without stimulation, the set-on-top technique has the economic edge. If a sub-commercial producer is obtained and a fracture treatment is necessary, the set-on-top completion has an initial advantage while the set-through technique, although more expensive, may pay out faster through more efficient use of stimulation techniques.

A major question is whether selective fracturing of zones penetrated or open-hole fracture treatment is better. Full evaluation of this subject has not been published. Most arguments to date have been based on hypotheses and guesses. Other than presently-known facts, the only criterion for determining which technique is better will be a comparison of productivity from each technique.

The difference of opinion of setting on top or drilling through, then, appears to revolve around the relative merits of open-hole fracture or selective fracturing through perforations. The problem is identical for selecting a completion program for shallow horizons.

Rotary Completions With Fluids Lighter Than Water

by H. J. Magner

Rotary completions with fluids lighter than liquid involve gas, air, foams, exhaust gases and inert gases. Aerated mud is not included in this list since it is not currently in prominent use and is not used in the Appalachian region today.

First large-scale use of gas as a completion fluid was in New Mexico's San Juan Basin where it proved a means to a very clean completion. It was adapted to the Pennsylvania area where cable tools were used to drill and set casing on top of the productive horizon.

Drying up the hole to achieve dust was a prime concern in this operation. Pressure of about 1 lb per 10 ft of depth was found adequate for good results in blowing out the hole and drying it up. In the winter, it was sometimes necessary to heat the gas for drying operations.

Time and expense can be reduced by drilling the cement plug with fluid. Normally, the mud pumps are not hooked up, but a pump truck is employed to circulate fluid already in the hole. The cement plug is then drilled.

While drilling, gas and foam chemicals are added to the fluid to obtain a fluffy, lightweight col-

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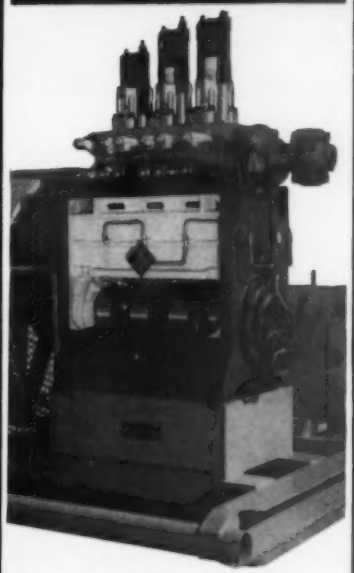

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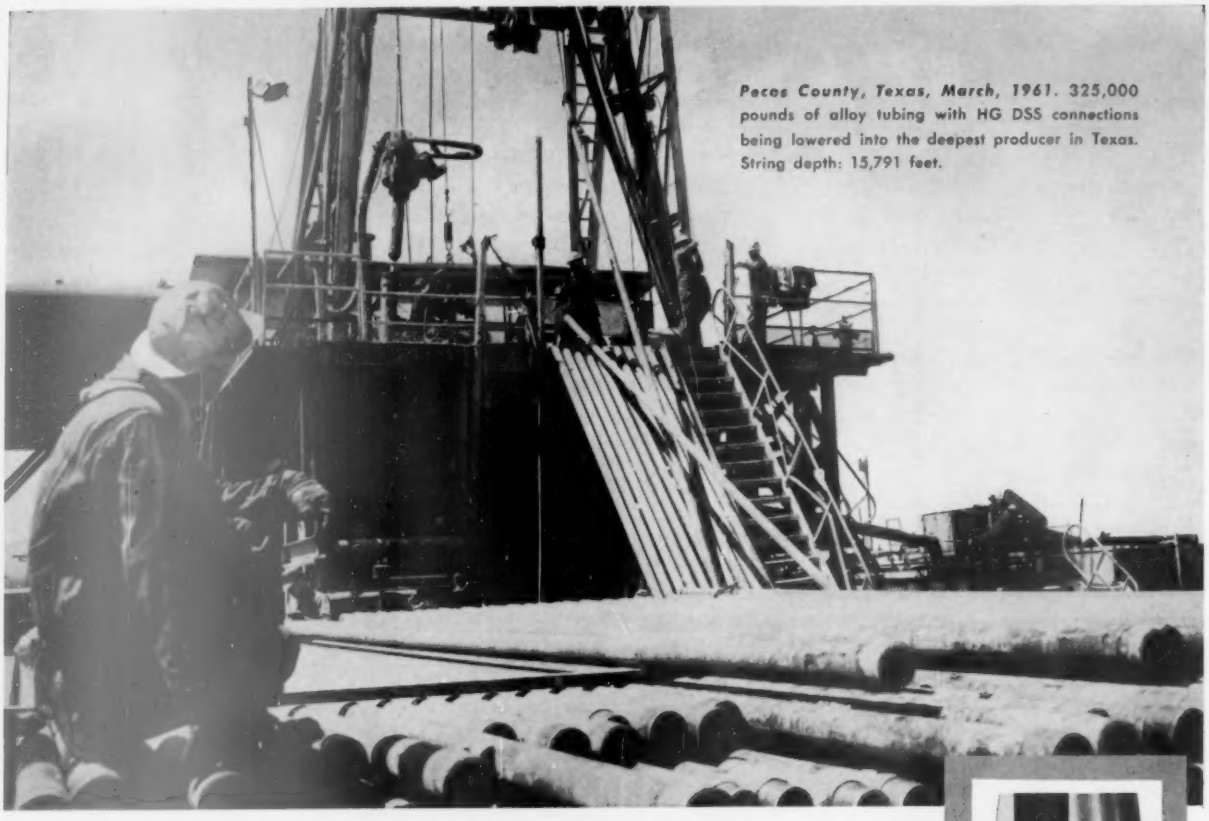

Pecos County, Texas, March, 1961. 325,000 pounds of alloy tubing with HG DSS connections being lowered into the deepest producer in Texas. String depth: 15,791 feet.

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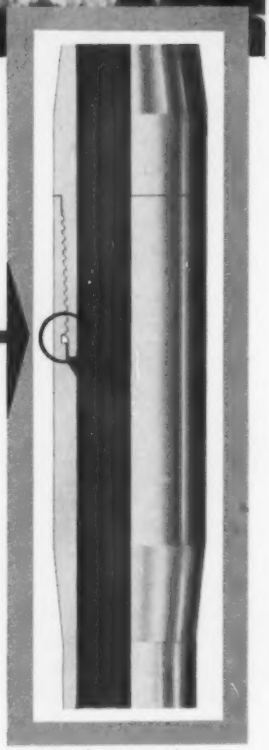

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umn in the casing annulus. The entire column is then blown and dried out before drilling operations are resumed. It is sometimes possible to blow the entire hole after the cement plug hits bottom and during WOC time.

Wells have been dried and casing tested in approximately 30 hr. In some cases, a few of the wells are drilled-in and completed in less than 48 hr.

Once the hole is dry, the producing horizon is drilled and drill pipe stripped out of the hole. The well is completed with the master gate on the hole. Open-hole fracturing is performed, usually after the rig is released. Safety precautions which can be expensive and time-consuming, include flaring drilling and produced gas at least 300 ft from the well.

The most important factor is the control necessary to handle pressures and volumes encountered in pay formations. Experience in the Basin to date has been excellent despite abnormally high pressures and high productivity potentials.

Drilling through the pay formation with air has been avoided in many instances due to the potentially explosive mixture of air and gas. If gas is available, of course, there is no need for using air since it is practical to drill with gas. But, on wildcat wells and in areas of low gas pressure, air has been used successfully.

There is little difference between drilling with air or gas. Since air is at low pressure, it may be necessary to use a booster compressor ahead of regular compressors. Hole-drying operations usually are slower due to greater amount of moisture in compressed air compared to dry gas.

Rotary for Shallow Drilling

Rotary methods using air can be used effectively to drill shallow wells to 4000 ft and less where small volumes and low pressures are involved. Studies are underway on the explosive potential downhole when using air as a drilling medium.

Surveys thus far indicate the mixture of air and gas has little chance to explode in an open hole without the presence of oil, water or foam. The mixture must be perfect over a given interval with heat or ignition conditions present: 10 to 12% gas in air is ideal for an explosion. Air drilling volumes vary from 1½ to 3,000,000 cu ft per day. A gas formation producing 150,000 to 300,000 cu ft per day would be the most likely situation to cause difficulty.

Surface damage has been nil in all reported cases of downhole explosions. However, pipe and drill collars have been melted causing expensive fishing jobs and sidetracking operations.

Foam Drilling

Rotary foam drilling is being used extensively in Ohio. This technique is a modification of air drilling. It is employed rather than mud when water flows are encountered above the pay horizon. In such cases, foam-forming chemicals are injected in the air stream and drilling continues to the casing point through the pay zone. Justification for its use is based purely on economics since drilling is much faster than with mud and almost as fast as when using air.

Many problems are inherent in this technique. Formations penetrated must be competent, not sloughing, to allow logging and casing operations. There is some danger when gas or oil is encountered since a cap or confinement is formed, and an explosive mixture is easily created in such a pocket.

Required air pressures are normally higher due to greater density of the foam in the annulus as compared to dry air or gas. Higher pressures result in high temperatures of the air and can cause ignition.

Various surveys throughout the U.S. indicate that this drill-

Better Production Tools Through Research

OTIS Equipment NEWS

Volume III, Number 3 **Otis Engineering Corporation • Dallas** *Production Equipment and Services*

Now...An Otis Flow Line Safety Valve And Pilot For Only $295.00

Proven Otis Safety Valve Design Costs Less Than Many "Substitute" Safety Devices

DALLAS—An all new flow line safety valve employing the time-proven Otis Safety Valve design is now available for installation on wells requiring shut-in protection in the event of flow line breakage. The new valve, designated the Type K Otis Flow Line Safety Valve, may be purchased in the popular 2-inch, 3,000 p.s.i. screw-end size complete with a new Type BE Otis Low Limit Pilot for $295. The Type K Valve is also available with flange-end connections at slightly higher cost. The valve and pilot are designed to automatically shut in a well when flow line pressure drops below the pre-set limit of the pilot. The pressure drop may be due to a break in the flow line itself or the malfunction of auxiliary equipment downstream of the valve. The new Type K Valve and BE Pilot combination offers oil and gas producers effective Otis Safety Valve protection at a new low price — a price which in many cases is lower than that of substitute safety devices such as diaphragm - operated motor valves, etc.

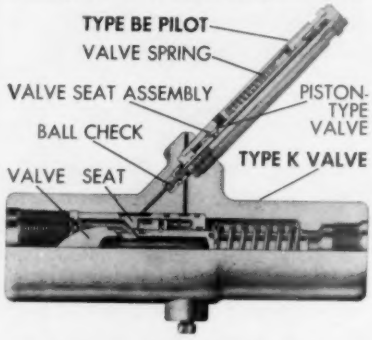
PRICES — TYPE K VALVE AND BE PILOT COMBINATION

Size — Type End	Working Pressure Rating (p.s.i.)	Price
2" — Screw	3,000	$295.00
2" — Screw	5,000	335.00
2" — Flange	3,000	345.00
2" — Flange	5,000	385.00

Note: Be sure to specify pressure range for pilot.

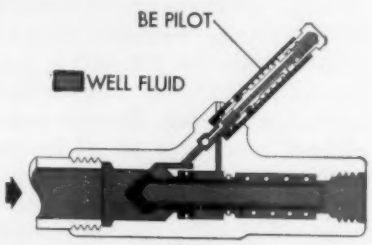
Valve Operating Principles

The Type K Otis Flow Line Safety Valve is a pilot-controlled pressure-operated safety valve designed to automatically shut in a well in the event of abnormal changes in pressure on the flow line or when control pressure from an external source rises above or falls below that for which the pilot is set. On installations where pressure from within the flow line is to serve as the pilot control medium (see schematic drawings), flow line pressure is equalized across the valve and the pilot to permit a spring in the safety valve to hold the valve piston off seat. When pressure within the flow line falls below the set pressure of the pilot, the pilot is designed to exhaust the pressure from behind the valve piston. This action serves to create a differential across the valve and allow flow to close the valve instantaneously. The valve is designed to be reopened by screwing in the nut on the pilot which acts to force the ball check in the pilot boss off seat to equalize pressure across the valve. When installed with the Type BE pilot, the valve serves to provide low-pressure protection. If both high and low pressure protection is desired, the Type E Otis Pilot is recommended. For remote protection, the Type N & P Otis Pilot combination is available.



Pilot Operating Principles

The Type BE Low Limit Pilot is a spring-loaded, pressure-actuated control pilot designed to actuate the Type K Otis Flow Line Safety Valve in the event of a drop in flow line pressure below the preset limit of the pilot. The pilot consists of a body, a piston-type valve and valve seat, and a valve spring. When installed on a Type K Valve, a port in the safety valve body, the pilot seat assembly, and the pilot valve serves to admit flow line pressure to the pilot. This pressure acts to hold the pilot valve on seat against the force of the valve spring. In the event of a pressure drop across the valve and pilot, the spring within the pilot is designed to force the pilot valve off seat, permitting the pilot seat assembly to move up so that the ball check in the safety valve boss can seat. This action serves to exhaust pressure within the valve, create a pressure differential across the valve and permit the valve to close.



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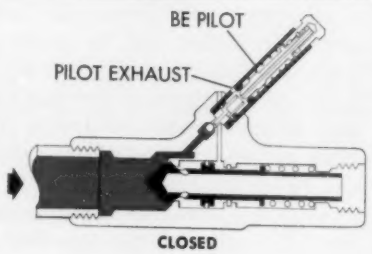

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Valve and Pilot Design Advantages

Both the Type K Otis Flow Line Safety Valve and the Type BE Otis Low Limit Pilot are of the simplest design and construction to provide reliable and positive operation. The flow path through the Type K Otis Flow Line Safety Valve has been engineered to permit high flow volumes with a minimum pressure drop. The valve was also designed with no small ports or natural body traps to avoid areas in which hydrates and/or paraffin might accumulate to foul the valve's operation. Both the valve and pilot are so designed as to permit each to be used with other Otis Safety Equipment.

Otis Surface Safety Valves and Pilots have long been recognized as the very finest. Otis Safety Valve Specialists have earned the same enviable reputation. Whatever your well safety valve requirements, Otis can be of help. For more information on Otis Safety Equipment, or for help with a specific safety valve installation problem, call the Otis office nearest you, or write Otis, Dept. 3-E, P.O. Box 35206, Dallas 35, Texas. You'll find experienced Otis Safety Valve Specialists ready to help you — anxious to serve you . . . with the widest variety of field-proven safety valves and pilots available today.

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ing technique has reflected the greatest number of downhole explosions. Damage to hole and pipe has been severe in many cases, but little or no harm has been reflected on the surface. Solution to the problem may lie in a reduction of pressures through better hole-cleaning foaming agents, thus reducing the chance of air-gas pockets.

Rotary Exhaust-Gas Completion

Engine exhaust gases in rotary completions are used in areas where gas is not available and where operators prefer not to risk air completion. This technique is usually employed where casing is set on top of the pay horizon.

Exhaust gases from the drilling rig and compressor engines are cooled, cleaned and compressed before piping down the drill string. Foam chemicals are injected into the exhaust gas stream to assist in lifting cuttings to the surface.

Explosive mixtures are eliminated, but other problems exist. Hookup required is both expensive and time-consuming. Engine exhaust gases are corrosive and damage compressors and cooling equipment. Formation samples are sometimes poor, and the hole is seldom clean. In fracturing operations, cuttings might be found up and down the pipe, and might even cover the pay formation face.

Inert Gas Completions

Use of inert gas as a drilling medium for well completions has the best potential for explosion-free drilling. This technique utilizes an inert gas generator. Natural or liquid gases are burned and the resultant products are cooled and cleaned before compression and injection into the well.

Equipment required would be rather expensive, perhaps $50,000. It might be used on a joint or rental basis if sufficient justification existed.

Inert gas studied was primarily nitrogen, around 88%. Carbon dioxide content was about 10%, and the remaining gas was oxygen and carbon monoxide which precludes any explosive mixture.

A number of rotary drilling techniques are available to the operator in the Appalachian area where problems are unique. Each well should be evaluated under existing conditions to determine the best technique and procedure.

Effect of Drilling Fluids on Production

by Andy Reid

It's a bit frightening to think of the production that must have been overlooked in past wildcat drilling because of damage done by drilling fluids to potentially-productive formations.

In many cases, wells have been abandoned after evaluation indicated they were not capable of commercial production. Then, someone else has come along and drilled into the same formation with a well-designed mud program and made a good well. Or,

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Wheland HP-16000 in Kingfisher County, Oklahoma. Left to right: Lavoy "Dink" Klutts, Tool Pusher; Jimmie Lynn Austin, V.P.; Paul Austin, Treas.

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By Jimmie Austin
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Formation Damage and Corrective Treatments.

	Surface Activity of Filtrate	Clay Hydration and Swelling	Mud Particle Invasion
Corrective Treatments	Con Det	Salt	DMS
	DME	Gypsum	Guar gum or CMC
	DMS	DMS	
	Trimulso	DME	Remove native solids
	Oil mud	Oil Mud	Dense salt solutions

a shallow formation may have shown good production possibilities, but, by the time the well had been drilled deeper to test other formations, the shallow one showed no potential.

Damage from the drilling fluid is often the culprit.

Drilling Mud Damage

Drilling mud can reduce primary permeability of sandstone in three ways: (1) surface activity blocking; (2) clay particle swelling; and (3) solid particle invasion.

The first type of damage involves water from mud filtrates with high surface activity invading the pore spaces of sandstone and being held in place by capillary forces. These water droplets can not be displaced by the oil or gas trying to move into the well bore.

Many sandstones have native clay particles in the pore spaces. When freshwater mud filtrate wets these clay particles, they swell and expand in place, reducing permeability of the sand.

Another type of damage can occur when solid particles from the drilling fluid invade pore spaces of the sandstone. Initially, when the sand face is first exposed to the mud and before a filter cake is built on the sand face, mud goes into the pore spaces carrying solid particles with it. After the filter cake is built and then removed during completion, these solid particles are still in the pore spaces and have reduced permeability.

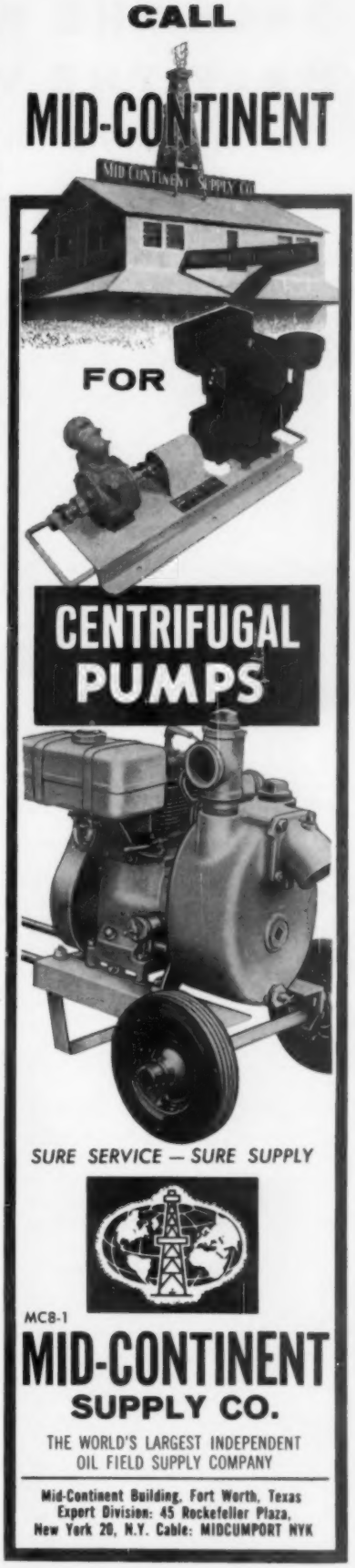
Each of these types of formation damage will yield to certain preventive or corrective treatments. The accompanying table shows some of the basic mud treatments available for reducing formation damage.

Surface activity damage can be reduced or eliminated by use of chemical surfactants which reduce surface activity of the mud filtrate to a safe level. Oil-base drilling fluids and water-in-oil emulsions also are answers to this problem.

Clay hydration and resultant swelling can be eliminated by treating the mud with large quantities of salt or gypsum or with certain chemicals which inhibit the filtrate. Again, the oil-base muds, since they contain no water, prevent swelling of clay particles.

Damage from solid-particle invasion of pore spaces can be reduced by making the mud solids large enough to keep them from entering the pores, or by completely eliminating solids from the mud. One surface active agent produces relatively large particles. Guar gum or CMC muds have extremely small particles. No-solids drilling fluids are usually salt solutions which can weigh up to around 14 lb per gal. Guar gums in combination with heavy salt solutions produce a good drilling fluid that permits control over filtration and viscosity.

A well-designed mud program based on types of production formations encountered can greatly increase chances of minimum damage to the formation. ■



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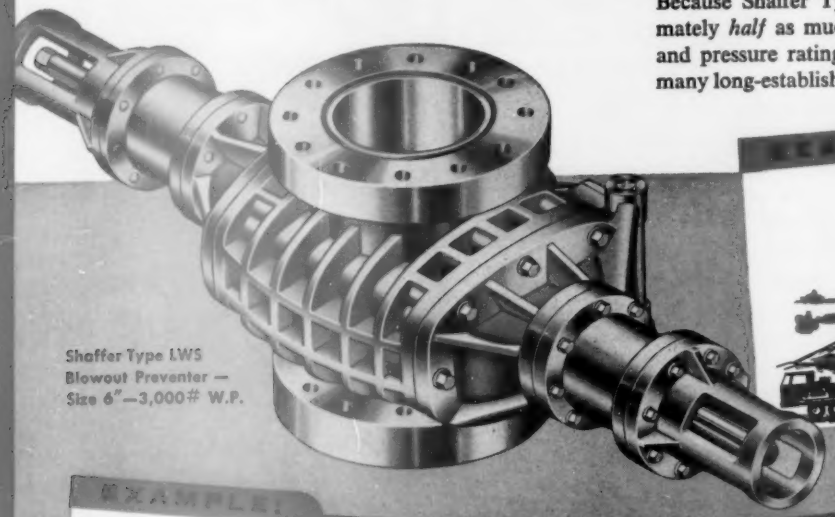
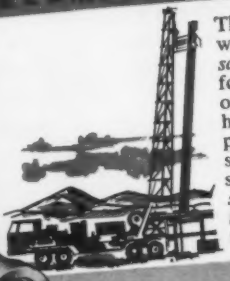


Shaffer Type LWS Blowout Preventer — Size 6"—3,000# W.P.

EXAMPLE!



The 6"—3,000# W.P. Preventer weighs only 780 lbs. *(a 67% saving in weight)* and is ideal for protection on quick in-and-out production jobs where the heavy weight of other types of preventers make adequate pressure protection impractical on such operations. Result—*greater safety is now possible on all types of production and well rework jobs!*

EXAMPLE!

On out-of-the-way rig sites where high transportation costs are a big problem, the 6"—5,000# W.P., 8"—3,000# W.P. and 10"—3,000# W.P. Type LWS Preventers with weight savings up to 64%, (see table below at right) are making possible major economies in shipping costs. Even on domestic wells, weight savings like these can mean the difference between using a big, costly truck or a small, inexpensive one—*plus additional savings in storage and handling costs all along the line!*

EXAMPLE!

Even the large 10"—3,000# W.P. Type LWS Preventer can be readily transported, *fully assembled*, by normal air cargo and helicopter lifts, saving vital time and slicing costs in jungle or arctic operations where roads are non-existent or are so impassable during certain seasons that heavier types of preventers cannot be transported to the rig site. *But with LWS Preventers, losses in rig-up time are virtually eliminated!*

FOUR POPULAR SIZES OF SHAFFER TYPE LWS BLOWOUT PREVENTERS

Nominal API Size	Working Pressure	Test Pressure	Vertical Bore	Approx. Weights		Approx. Saving in Weight*
				Single	Double	
6"—3,000# W.P. (6" Series 900)	3,000 PSI	6,000 PSI	7 1/16"	780 lbs.	1,420 lbs.	67%
6"—5,000# W.P. (6" Series 1500)	5,000 PSI	10,000 PSI	7 1/16"	1,410 lbs.	2,610 lbs.	55%
8"—3,000# W.P. (8" Series 900)	3,000 PSI	6,000 PSI	9"	1,100 lbs.	1,950 lbs.	64%
10"—3,000# W.P. (10" Series 900)	3,000 PSI	6,000 PSI	11"	2,100 lbs.	3,850 lbs.	45%

*As compared with comparable equipment now in use.

INCORPORATE THE LATEST SHAFFER ADVANCEMENTS—Although they are light in weight (made possible by a unique Shaffer "deep-rib" steel casting technique) Type LWS Preventers incorporate all the latest Shaffer advancements—advancements still not found on other preventers that weigh *twice* as much . . . **Swinging END-Opening Doors** for quick, simple ram changes without loss of operating fluid . . . **Positive "In-Line" Power Drive** with each ram and its operating piston on opposite ends of a *single* stainless steel shaft (no levers, yokes or other complex connections between the ram and its operating piston) . . . **Quick-Drain Ram Compartments** that prevent detrimental accumulation of mud and sand—*and many other important advancements found only in Shaffer Preventers!*

SEE your nearest Shaffer representative for complete data on the savings you can make with the *lightweight* Shaffer Type LWS Blowout Preventers. Or Write Direct!

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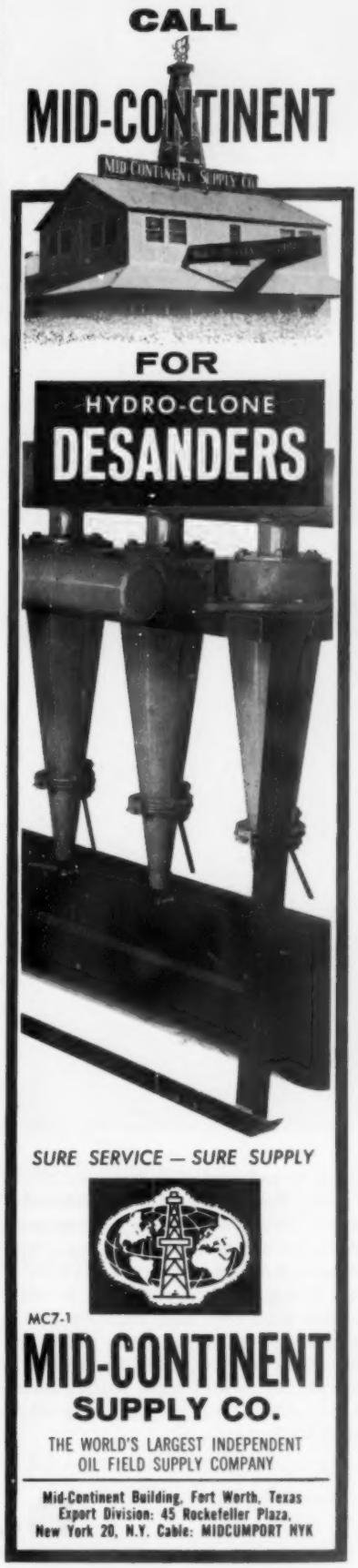
Eastern District API Makes Awards . . .

API Citation for Service awards for outstanding service to the petroleum industry were presented at the Eastern District meeting by Gage Lund (second from left), vice president of Standard Oil Co. of California and API vice president for production, to: (left to right) N. C. Ludwig, Universal Atlas Cement Co., Gary, Ind., James M. Bird (dark suit) Birdwell Division, Seismograph Service Corp., Tulsa, Okla., and H. J. "Red" Magner, vice president and eastern manager of operations for Delta Drilling Co., Pittsburgh.

. . . Elects Officers

Carl Hauck, Ohio Fuel Gas Co., Columbus, Ohio, (second from left) was elected chairman of the Eastern District API Division of Production, succeeding W. B. Maxwell, United Fuel Gas Co., Charleston, West Va., (third from left) who was elected chairman of the District Advisory Committee. Other officers shown are (left to right) H. T. Heuple, Manufacturers Light & Heat Co., Pittsburgh, Hauck, Maxwell, Jack L. Trittipo, United Carbon Co., Charleston, West Va., J. Robert Hornor, Delaware Gas Co., Clarksburgh, West Va., and D. C. Hubbard, Ohio Fuel Gas Co., Columbus, Ohio. The latter are three of the 15-man district vice chairman group. All will serve during the 1961-62 term.



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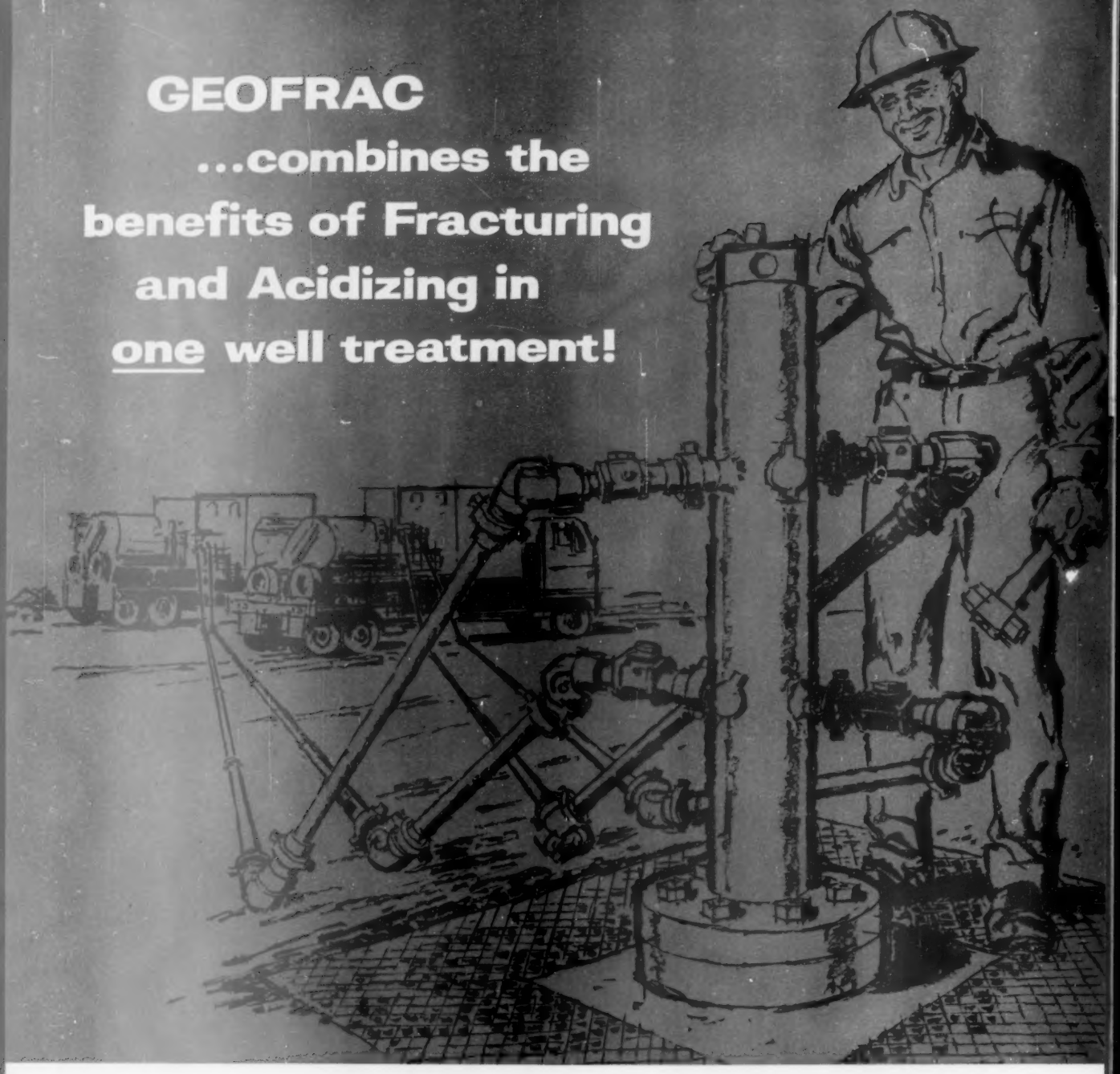

Fracture and acidize in *one* operation with this superior BJ Service treating fluid. An acid in oil emulsion, Geofrac is a dual-purpose, sand-carrying fluid that has proven especially effective in limestones, dolomites and conglomerates, or other formations where carbonate dissolving action is desired. After the fracturing phase, with pumps shut down, Geofrac *continues* to work chemically within the pay. Its low fluid loss, high viscosity and temperature stability provide deep formation penetration—with no external gel breakers required. Selective, too. Since oil is the external phase, Geofrac penetrates oil-bearing formations more readily than water-bearing ones. Geofrac is available in both 5% and 15% inhibited acid strengths—and *only* from BJ Service.

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Designed and built by BJ Service, this superior all-purpose unit pumps the highest fluid rates in the field (up to 45 BPM)...also handles high-pressure jobs with ease. Commander features include two triplex ram pumps...engines with a high horsepower/weight ratio...automatic exhaust cooling...smooth performance at all speeds and pressures.

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CEMENTING DATA

Job — Hattie S. Welch #1, Jefferson Davis Parish, South Louisiana

Drilling Contractor — The Bullard Drilling Co., Inc., Houston, Texas

Owner — Austral Oil Company Incorporated, Houston, Texas

Job #1 — 7⅝" O.D. casing string set at 10,277' in 10⅝" hole, cemented with 500 bags UNAFLO cement plus 6% gel (slurry wt. 14.7 lbs/gal.) followed by 200 bags UNAFLO cement neat, (16.3 lbs/gal.). Drilling mud wt. 13.4 lbs/gal. Schlumberger temp. log 181° F. Est. static BHT 213° F.

Job #2 — 5½" O.D. liner, 2,146' long, bottomed at 12,000' in 6¾" hole cemented with 320 bags neat UNAFLO cement. Drilling mud wt. at cementing 16.4 lbs/gal. Schlumberger temp. log 255° F. at 12,160'. Est. static BHT 265° F.

Job #3 — 5½" O.D. full casing string tied to top of 5½" O.D. liner, using liner to casing coupling with 100 bags neat UNAFLO cement.

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UNAFLO oil-well cement is successfully used neat or with various types of additives in more and more cementing operations. For cementing casing or liner, squeeze cementing, plug-backs or recementing, UNAFLO cement slurries pump easily and set hard to provide an adequate seal. Its retarded set sustains high initial fluidity despite high temperatures and pressures. This allows time for proper placement plus a margin of safety for delays or emergencies.

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HUGHESITE - the superior hardfacing

Oxy-Acetylene

Long-lasting and dependable protection of tool joints against abrasive wear is assured through the use of *Hughesite*—many times harder than hardened steel. Today, Hughes offers a choice of two superior methods of applying *Hughesite:* the new "HughesArc" application or Oxy-Acetylene.

In the improved Oxy-Acetylene application—developed by Hughes—wear-resistant *Hughesite* particles are distributed evenly throughout the hardfaced area. This assures maximum protection of the tool joints under severe abrasive conditions.

In the Oxy-Acetylene hardfacing method, *Hughesite* is applied in circumferential, interrupted grooves, using a special alloy steel binder to bond the hardfacing to the tool joint metal. On tapered tool joints, fingers of hardfacing are extended through the circumferential lands and down the elevator shoulder to provide extra protection in these critical wear areas. On square shouldered joints, half moon pads of hardfacing, applied by a newly patented method, prevent undercutting of the shoulder.

Oxy-Acetylene hardfacing is available on both "Flash-Weld" and "Seal-Grip" tool joints.

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Oxy-Acetylene and *HughesArc* hardfacing get their superior wear resistance from the *quality* of the hardfacing material used—Hughesite—made by Hughes to specifications developed by Hughes. It is the most wear-resistant material that can be successfully used to hardface tool joints. Its quality is guarded by close manufacturing controls. First developed to hardface rock bit teeth, Hughesite has been used for the past 20 years to hardface Hughes tool joints. This extensive experience in processing and applying Hughesite is another reason why Hughes hardfaced joints today withstand the shock and abrasion of rotary drilling.

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HughesArc uses the new consumable electrode method. In this method, Hughesite—hardest known man-made facing material—is fed automatically into the molten weld puddle just before it solidifies to obtain a uniform distribution of the Hughesite particles.

Special steel binder, more wear resistant than the tool joint itself, is used to bond the Hughesite particles to the tool joint metal.

HughesArc hardfacing—now available on all Hughes "Flash-Weld" joints—has been thoroughly field-proved. Over a period of years thousands of HughesArc hardfaced tool joints, divided among a large number of experimental groups, have been run in California, Canada and the Gulf Coast under continuous field observation. During the past year, many HughesArc drill strings have been placed in service in these same areas.

HughesArc hardfacing is being offered in the density and coverage best suited to the abrasiveness of the formations in which the drill strings are to be used.

HughesArc is offered in both flush and oversized (raised) applications.

On all tapered tool joints, fingers of hardfacing are extended down the elevator shoulder to provide maximum protection for this critical wear area. On square-shouldered joints, a newly patented method of applying hard pads to the shoulder is being used to prevent undercutting.

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Your Hughes representative can recommend the type of hardfacing that will provide the most economical protection for the service in which your drill string is likely to be used.

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"After 19 months, the core of our UNI-CORE Sand Line was in good shape. Gave nearly twice the service we would normally expect before the wires began to wear."

—Texas well servicing company

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"Where acid was being used in our wells, plastic core, Union cable tool drilling line outlasted other brands. We also use Union Sand Lines with plastic core and they are doing an outstanding job."

—Illinois tool pusher

It Pays to Listen

Here's what they say about UNION'S UNI-CORE® cable tool and well servicing lines

New steels are born at Armco

UNI-CORE Service Line
Photo of a section of UNI-CORE Sand Line showing plastic core. Engineered to resist heat, acids—other enemies of long core life.

UNI-CORE Cable Tool Line
Developed to give the same outstanding performance in cable tool drilling as Union's UNI-CORE well servicing line.

"Rough duty since Dec., 1960 . . ."
"We gave UNI-CORE the works in servicing wells 10,000 feet and deeper. We check the line constantly. It has shown no breaks and has not pulled down in any place. No other make has given us such service."

—Oklahoma well servicing company

"We get better wear . . .
out of our UNI-CORE Sand Lines than any we have ever used. We bought Union cable tool line on the basis of our sand line service."

—W. Va. tool pusher

Here's first-hand proof from the field. Read what the tool pushers and the oil well servicing people themselves think of UNI-CORE.

They're getting greatly lengthened service, less down time and saving money through safe, efficient wire rope performance.

UNI-CORE Sand Line is the wire rope with the plastic core instead of fibre or wire. It is designed for the special needs of oil well servicing. It has superior resistance to compression, elongation, heat, acids and salt water — the natural enemies of long wire rope life. Cable tool pushers are getting the same superior service from UNION'S UNI-CORE Cable Tool drilling lines.

For quality wire rope for every need in the oil industry, call any leading oil field supply store or write: **Union Wire Rope, Armco Steel Corporation, 2106 Manchester Avenue, Kansas City 26, Mo.**

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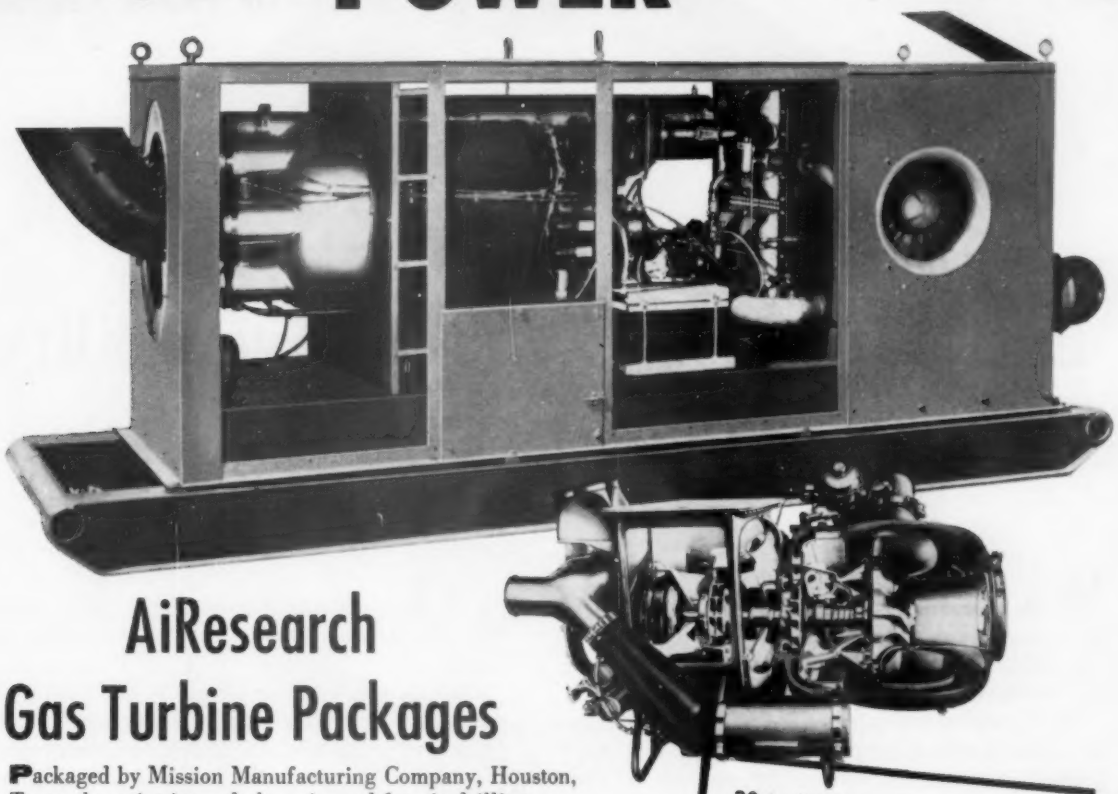

AiResearch Gas Turbine Packages

Packaged by Mission Manufacturing Company, Houston, Texas, the unit pictured above is used for air drilling and is representative of a number of different types of AiResearch industrial gas turbine power packages now available. These lightweight, compact gas turbine packages provide portable compressed air and shaft power for a wide variety of industrial applications.

The basic power package consists of an AiResearch gas turbine compressor and power unit designed around components and accessories proved by laboratory and field testing over a period of years. It is mounted on a skid, enclosed against the weather, with heat exchangers, operating controls and safety devices.

The Mission packaged GTC 105 AiResearch Gas Turbine Compressor Unit pictured above supplies compressed air only. The cutaway Model GTCP 85-91 AiResearch Gas Turbine Compressor and Power Unit provides shaft horsepower and compressed air simultaneously, or either form of power independently and interchangeably. Other models are also available to supply either type of power alone.

AiResearch Manufacturing Division of Arizona is a world leader in the design, development and manufacture of lightweight turbomachinery.

30 to 850 horsepower in a lightweight, compact, dependable package.

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by Dr. Paul B. Crawford

Estimate Deep Well Deliverability From Wellhead Pressures

With a simple but reliable correlation procedure you can estimate deliverability of deep gas wells from pressure measurements made at the wellhead.

The correlation is easy to apply: a straight line results on log-log paper when gas flow rate is plotted against difference in squares of the static and flowing wellhead pressures.

Its validity for a wide range of well depths, tubing sizes and reservoir pressures has been confirmed by many hundreds of computations. This article gives actual field data on its application to wells in the 10,000 to 12,000-ft range.

For many pipeline deliverability estimates the wellhead correlation is far superior to the conventional sand-face correlation method, since it eliminates need for calculating pressure drop from the sand-face to the wellhead.

It offers accuracy comparable to more complex methods in current use.

Pierce-Rawlins Method

For more than 30 years petroleum engineers used the Pierce and Rawlins technique for estimating gas flow from a well. Deliverability of gas to the sand-face is determined by plotting on log-log paper difference in static sand-face pressure squared minus flowing sand-face pressure squared (Y-axis) vs the flow rate (X-axis). Sand-face pressure can be ascertained at various gas producing rates.

To find wellhead or pipeline deliverability, pressure drop from sand-face to wellhead then must be calculated. Wellhead deliverability is of great importance, because this pressure determines quantity of gas available above a particular pressure required for certain transmission lines, gathering lines or gas processing plants.

Calculating pressure drop in the tubing is a trial-and-error procedure. Consequently, many engineers use a median or average temperature and guess at the pressure. The calculation is continued until the assumed pressure is sufficiently close to the trial valve. Since trunk transmission lines are frequently tied into several hundred gas wells, the task of calculating wellhead deliverability for all the wells is formidable even with electronic computers.

It is difficult to show entirely from mathematical considerations that a straight line will result in using the wellhead pressure correlation. To establish such a relation, pressure drop from reservoir to sand-face and from sand-face to wellhead must be calculated. Laws describing flow of gas in rock and pipe differ. In making the first trial, it is necessary to assume average gas properties; loss in accuracy immediately follows.

Wellhead Method Tested

The wellhead correlation method has been used by engineers in certain applications for a number of years, but until now its range of application and validity has not been described in the literature. Deeper gas wells are much more difficult to compute than shallow formations, and the gas goes through considerable change in temperature, pressure, viscosity and compressibility in flowing up the flow string.

Therefore, a systematic study was made to determine validity of the wellhead correlation

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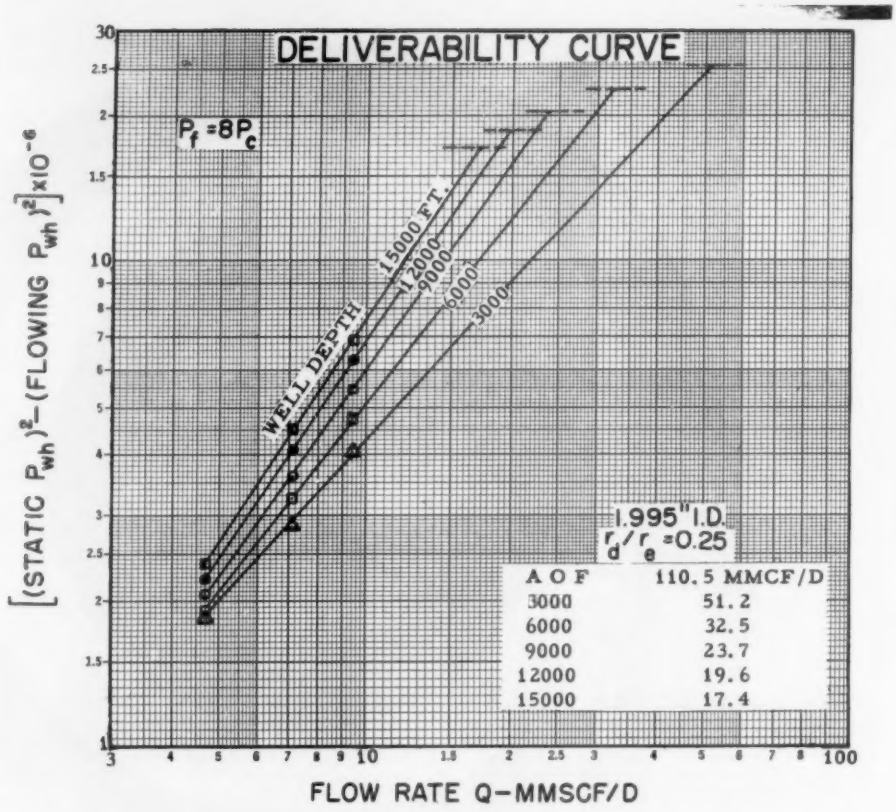

Fig. 1

procedure for these deep wells at different pipe and reservoir conditions. Several hundred computations were made using very small increments both for the flow in the formation and flow up the tubing. The method used was that described in *The Petroleum Engineer*, Vol. 31, No. 12, p. B-82, November 1959.

To compute pressure drop for flow up the tubing, the tubing was divided into 1000-ft increments and a trial-and-error calculation was made to insure that the average pressure and temperature in the 1000-ft interval under consideration were equal to the assumed values.

If this was found to be true within the desired accuracy, the pressure at the next interval was then calculated and the process was repeated until the pressure difference was determined from the sand face to the wellhead. At each 1000-ft interval, detailed consideration was given to the change in temperature, density, viscosity, pressure and compressibility which occurs when gas flows up the well.

In separate calculations the shutin reservoir pressure was assumed to be equal to 8, 6, 4 and 3 times the pseudo-critical pressure of the gas. For each reservoir pressure the basic sand-face deliverability curve and subsequent pressure drop in the tubing were calculated.

The series of tests proved that taking the static wellhead pressure squared and subtracting the flowing wellhead pressure squared and making a plot on log-log paper of this function vs the flow rate gives a straight-line deliverability curve.

This straight-line relation resulted for all reservoir depths from 3000 to 15,000 ft and was independent of the size of the flow string for the range studied. The correlation was tested for tubing of 1.99, 2.44, 2.992, 3.475 and 4.00 in. ID.

Calculated Results

Fig. 1 shows plots of the proposed deliverability curves for the case in which the shutin or static formation pressure was equal to eight times the critical pressure. (Note that absolute open flow, AOF, or wellhead deliverability, is tabulated in the inset of Fig. 1 through 6.) The pseudo-critical pressure of natural gas is usually between 650 and 675 psia; consequently, the calculations apply to reservoirs of about 5400 psi.

Computations are shown for the use of 2-in. tubing which has an ID of 1.995 in. In making the calculation it was assumed that the pressure of eight times the critical pressure existed at

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Retarded Acid Gets Results in Problem Wells

This table shows some of the recent results of Retarded Acid treatments performed by Dowell on problem wells in many areas. We hope it gives you some ideas that will result in greater profits from your wells.

LOCATION	NAME OF FORMATION	AMOUNT OF RETARDED ACID	RESULTS
Albert, Canada	Slave Point Mid Devonian Vugular lime	4000 gallons (acid-oil-emulsion type)	Production from old well went from 0 to 218 bopd.
Franklin County, East Texas	Limestone	30,000 gallons	16-fold gas production increase—from 400 mcfd to 6400 mcfd.
San Juan County, Utah	Paradox (Desert Creek Zone)	75,000 gallons (acid-oil-emulsion type)	Production boost from old well was 34 to 450 bopd in field where regular acid treatments are usually unsuccessful.
Ellis County, Kansas	Kansas City Lansing	2000 gallons (acid-oil-emulsion type)	Production nearly three times that of offset wells. $881 treatment cost paid out in 19 days.
Andrews County, West Texas	Pennsylvanian	10,000 gallons (acid-oil-emulsion type)	Production from old well boosted from 10 bopd to 60 bopd stabilized. This 50 bopd increase was made in a field where offset wells treated with 10,000 gallons regular acid usually yield an uneconomical 5 bopd increase.
Logan County, West Virginia	Big lime	4000 gallons	Production increased 100-fold to one million cfpd. Treatment cost paid out in two weeks. Entire well cost paid out in less than five months.
Lea County, New Mexico	Wolfcamp lime	3000 gallons (regular type) 15,000 gallons (acid-oil-emulsion type)	Well tested 275 bopd flowing. Other wells in field, given regular acid treatments, do not usually respond properly.
San Juan County, Utah	Paradox	40,000 gallons	Decline rate was reduced by treatment. Production was increased from 200 bopd to 700 bopd. Six months later production was still 700 bopd.
Alberta, Canada	D2	5000 gallons	Production from eight-year-old well had declined to zero with fluid level only 65 feet. One month after treatment, production had leveled off at 100 bopd, flowing.
Russell County, Kansas	Kansas City limestone	3000 gallons	Production boosted from 3 bopd to nearly 2000 bopd on test after clean-up.
McKenzie County, North Dakota	Madison lime	7000 gallons (acid-oil-emulsion type)	Production from old well increased from 35 bopd to 133 bopd after treatment. $3101.00 treatment paid out in 23 days.
Harrison County, East Texas	Pettit Oolitic lime	7000 gallons	Treatment of six-foot pay resulted in 40 mmcfd well with 60 barrels petroleum liquids per million.
Wabash County, Illinois	O'Hara lime (Highly soluble)	3000 gallons (acid-oil-emulsion type)	Well production stabilized at 75 bopd and treatment cost paid out in ten days. Regular acid had given poor results on nearby wells.
Fremont County, Wyoming	Embar lime	5000 gallons (acid-oil-emulsion type)	21 boph test from a pay that had been acidized and abandoned several years before. This treatment saved a well that would have been plugged otherwise.

Almost without exception, these treatments employed other Dowell products and services in addition to Retarded Acid. Most of the more recent treatments listed here were designed by Dowell engineers with the aid of the Acid Guide* – a method developed by Dowell for use in engineering acid treatments to get optimum results.

Take full advantage of Dowell's long experience, proved additives, and engineering ability. Call Dowell to perform your next acidizing treatment. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma.

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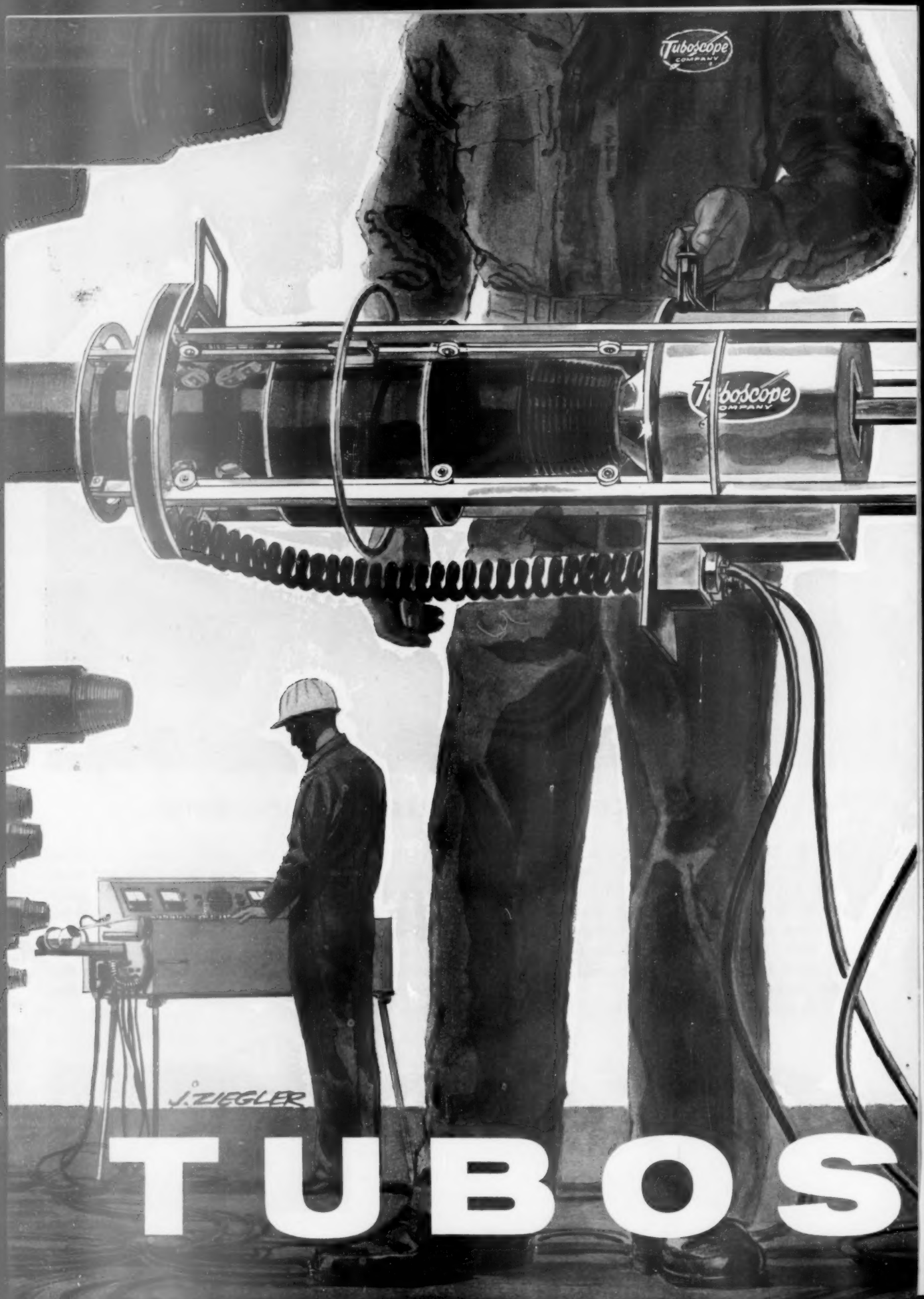
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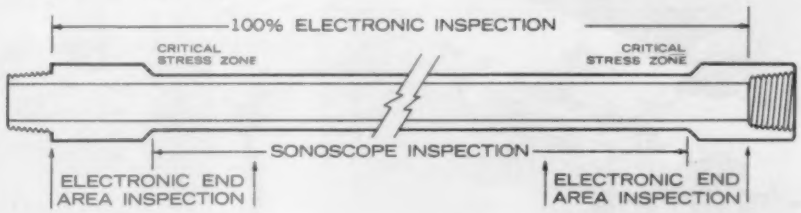

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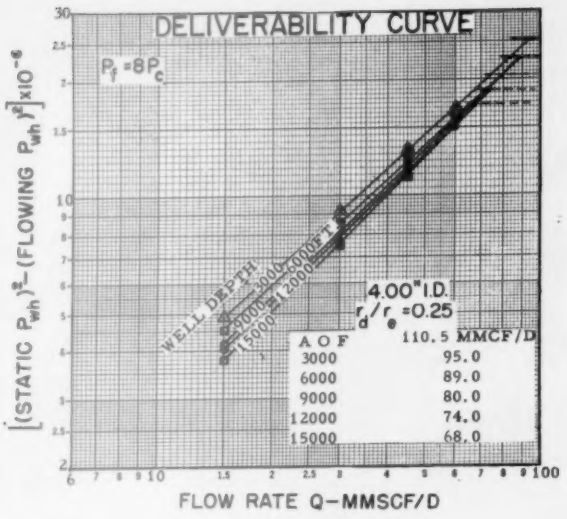

Fig. 2

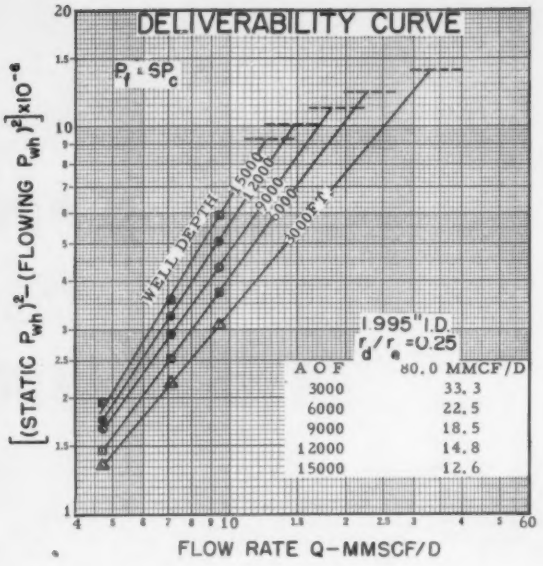

Fig. 3

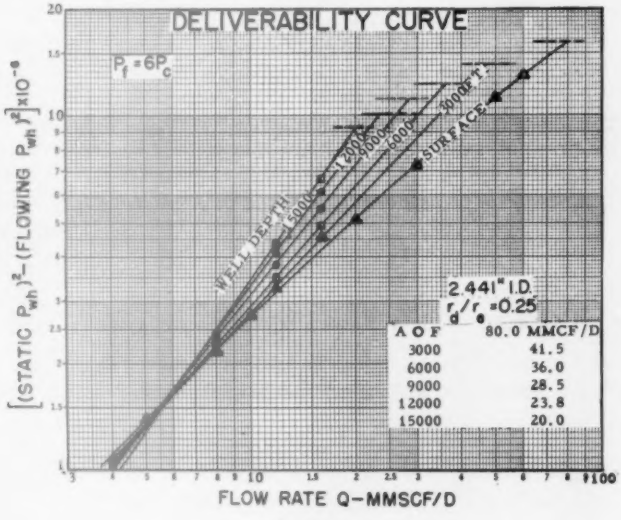

Fig. 4

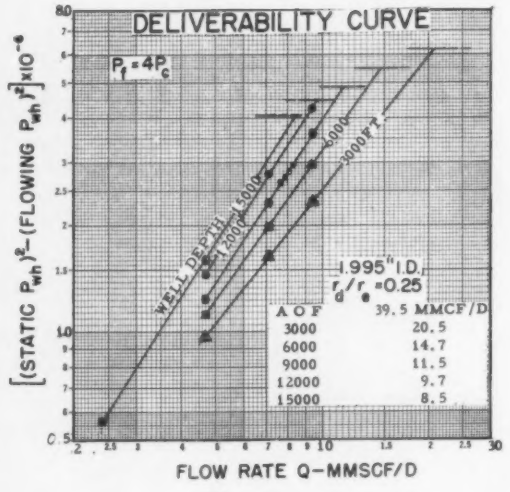

Fig. 5

reservoir depths of 3000, 6000, 9000, 12,000 and 15,000 ft depth. A similar calculation was made for 2½, 3, 3½ and 4-in. tubing.

Fig. 2 shows plots for the use of 4-in. pipe. Data are not shown for the use of intermediate flow strings but these data also resulted in straight-line plots.

Fig. 3 and 4 show wellhead deliverability curves for the case in which the shutin formation pressure was equal to six times the critical pressure. This corresponds to a reservoir pressure of about 4000 psi. Fig. 3 shows results for the use of 2-in. tubing and for tubing lengths ranging from 3000 to 15,000 ft and Fig. 4 shows similar results for the use of 2½-in. tubing. Similar curves were found for the use of 3, 3½ and 4-in. pipe.

Fig. 5 shows the calculated plot of the correlation for the case in which the reservoir pressure was four times the critical pressure (about 2700 psi) and the flow string ranged in depth from 3000 to 15,000 ft. The data apply for the case of 2-in. tubing. Similar data were also prepared for the use of 2½, 3, 3½ and 4-in. pipe and in each case a straight line resulted.

Fig. 6 shows similar data for the use of 2½-in. tubing and for the case in which the

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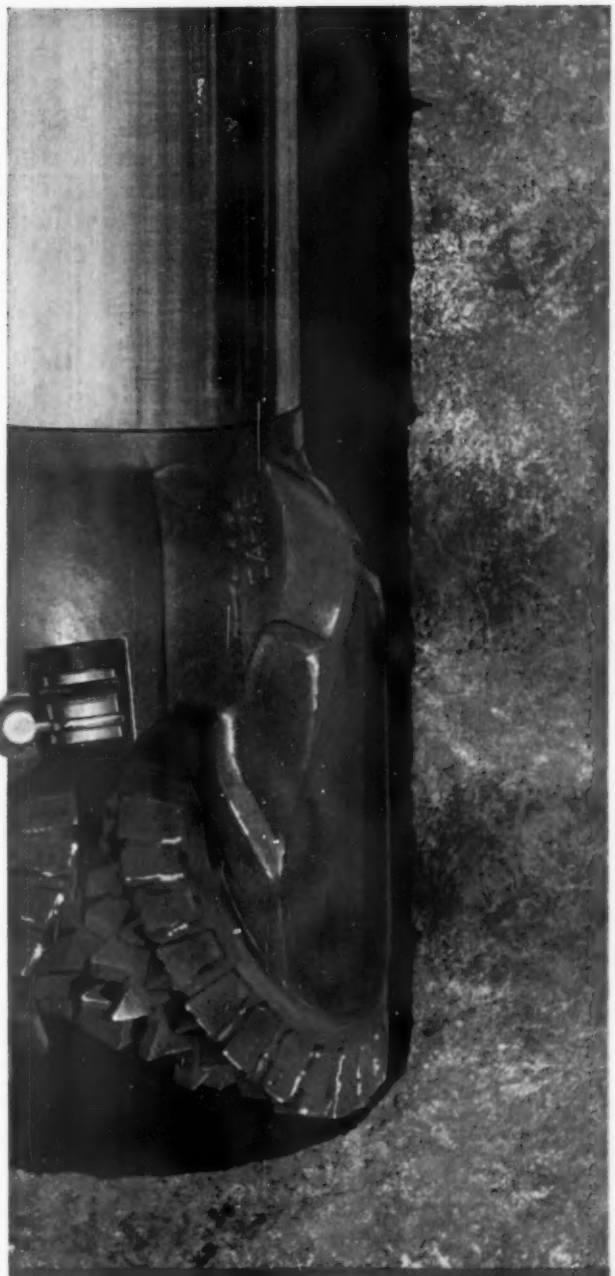

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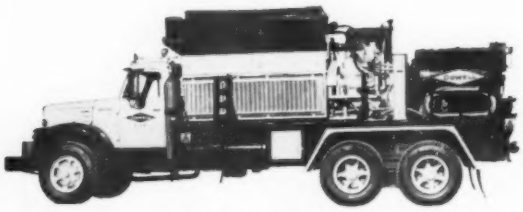
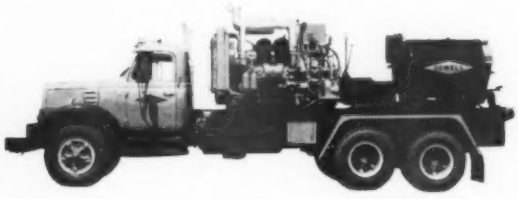
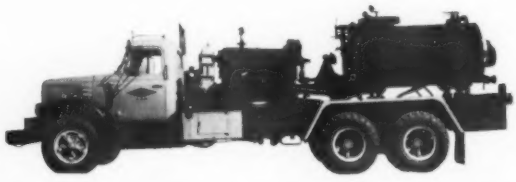


ALLISON PUMPER. 615 hydraulic horsepower rated output. Pressures up to 10,500 psi. Volumes up to 828 gpm. Operates from remote control panel.



TWIN DIESEL PUMPER. 306 hydraulic horsepower rated output. Pressures up to 10,500 psi. Volumes up to 828 gpm.



DOWELL "TP" PUMPER. 175 hydraulic horsepower rated output. Pressures up to 10,500 psi. Volumes up to 828 gpm.

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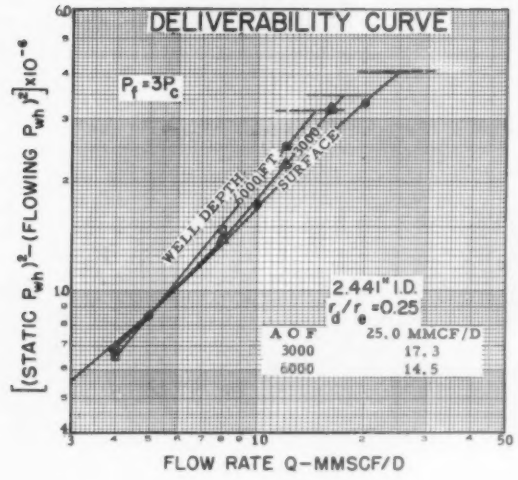

Fig. 6

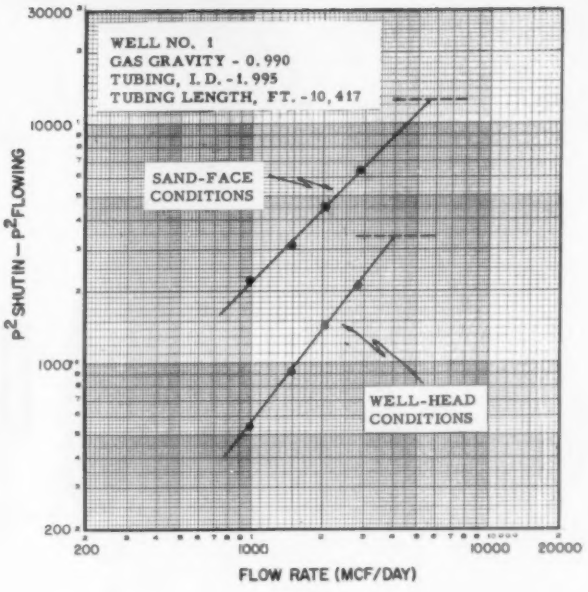

Fig. 7

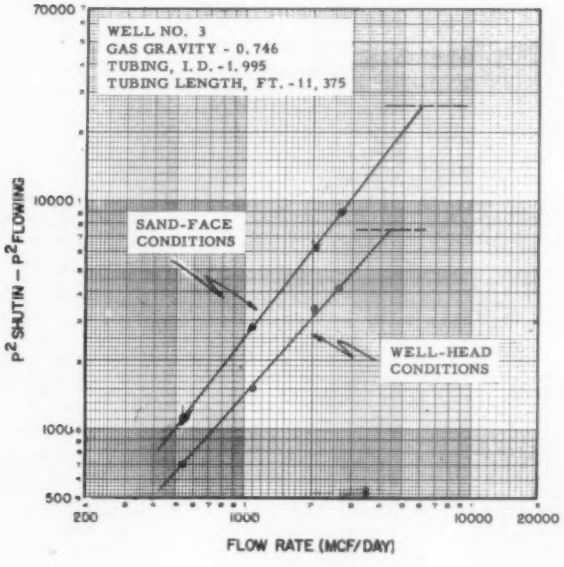

Fig. 8

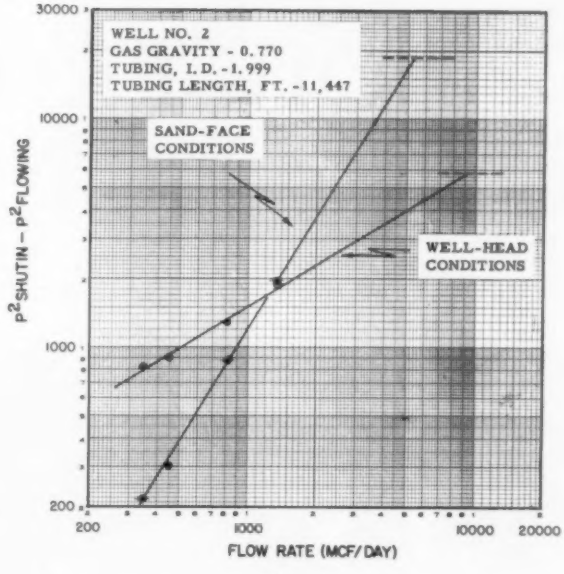

Fig. 9

reservoir pressure was three times the critical pressure (about 2100 psi).

Actual deliverability curves observed on two gas wells are shown in Fig. 7 and 8. In these cases the tubing length ranged from 10,417 ft to 11,375 ft. Gas gravities were 0.99 and 0.746. In both cases 2-in. tubing was used. A bottomhole instrument was run and the flowing wellhead pressure recorded.

Notice that a straight line resulted for both the sand-face correlation and the wellhead correlation. Four data points were available for each case. Additional field data not given here have shown similar results.

Liquid Standing in Hole

When liquid stands in the pipe of a gas well, it is usually impossible to calculate the static bottomhole pressure from the surface pressure reading unless height and density of the liquid column are known. The wellhead or surface pressure will read too low when liquid is in the hole. The calculated bottomhole pressure assuming only gas in the hole will be in error depending upon gas pressure, well depth and the amount and density of liquid in the hole.

Static weight of the gas column is frequently about 10% of the magnitude of the reservoir

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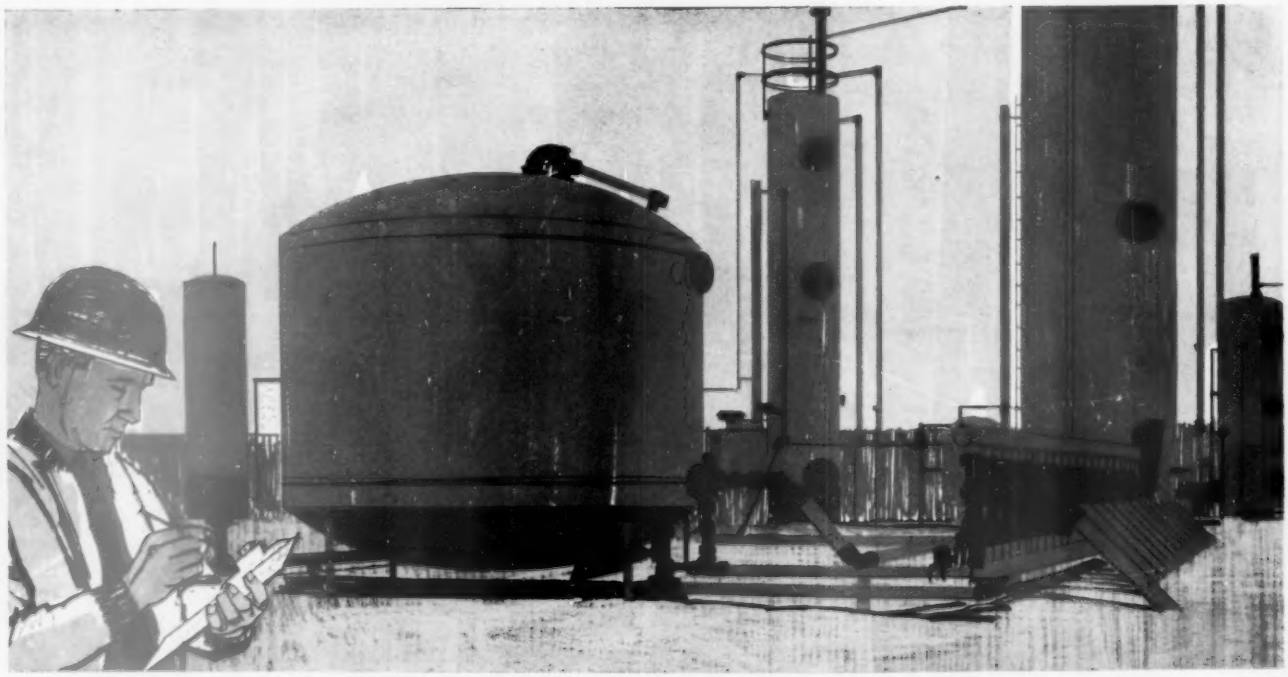

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pressure. If compressibility data for gases are used to calculate the bottomhole pressure from surface pressure measurements, the compressibility data are usually assumed to be accurate within about 2%; however, this 2% error applies only to the weight of the gas column.

Since weight of the gas column is about 10% of the total reservoir pressure, the error introduced by calculating static bottomhole pressure from surface pressure measurements is frequently in the range of 0.20%, usually about as good as can be achieved with even a carefully calibrated bottomhole instrument. Primarily for this reason it is possible to make an accurate bottomhole pressure calculation from a surface pressure measurement.

When liquid stands in the hole, static wellhead pressure may be a few hundred psi less than it would be if no liquid were in the hole. Then, when a flow test is initiated, the well will start cleaning out and the recorded wellhead pressure may show an increase during flow. This phenomenon has been observed in the field many times; i.e., the flowing wellhead pressure may be greater than the static or shutin wellhead pressure.

When liquid does stand in the pipe, the engineer must be unusually careful as the flowing wellhead pressure may be greater than the static wellhead pressure. There is no simple means of handling this type of data point.

False Deliverability Curve

The wellhead pressure correlation proposed here has been applied to several wells in which 1000 or more feet of liquid was standing when the static wellhead pressure was determined. This meant that the static wellhead pressure was several hundred psi less than it would have been if the tubing contained only gas. When flow started, in some cases, wellhead pressure increased as indicated above; however, at sufficiently high flow rates, wellhead pressure was less than the original static pressure with liquid in the hole. Nevertheless, eliminating the cleanout period, a plot using the wellhead pressure resulted in a straight line using the four-point method applied here. A typical curve is shown in Fig. 9.

Pressure measurements were made with a bottomhole instrument and with a surface pressure instrument. Note the lower slope which occurred when liquid was standing in the hole; the slope was much less than 45 deg. This lower slope should be expected at any time the static surface pressure reading is too low.

The reasons are quite simple. If the surface pressure reading is too low, then a plot of the static pressure squared minus the flowing pressure squared will give a number which is too small. If the number is too small it will plot too low on the figure, giving the lower slope.

This change in slope should be a key as well as a warning when the wellhead correlation is used. In all cases when the wellhead correlation was calculated, the slope of the curve was slightly greater than the sand-face pressure deliverability curve. (See Fig. 1-6.)

Another odd characteristic resulting when liquid stands in the well is that the wellhead deliverability curve would predict an absolute open flow greater than that obtained by the sand-face correlation. Such is incorrect, but note that in Fig. 9 the absolute open flow of the well using the sand-face pressure correlation would be approximately 50,000 Mcf per day whereas the absolute open flow using the wellhead correlation would be approximately 90,000 Mcf per day.

By contrast the absolute open flow shown in Fig. 1 through 6 indicates that flow decreases as depth increases. This is to be expected since additional resistance must be overcome when gas flows through the pipe.

Fig. 1 and 2, 3 and 4, and 5 and 6 may be used to show the influence of tubing size on wellhead deliverability. A comparison of Fig. 1 and 2 shows that wells may have their wellhead deliverabilities increased by a factor of two to four by changing from 2 to 4-in. pipe. The increase in deliverability depends on the tubing length. Similar comparisons may be made using 2 and 2.5-in. pipe in Fig. 2 through 6.

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3. Cook, Richard G., "Predicting Delivery Rates from Underground Storage Projects," Gas Vol. 35, No. 2, pp. 59-63 (Feb. 1959).

4. Walker, Corliss, Miller and Dunning, "How Gas Storage Wells Behave," (Part 2) The Petroleum Engineer, Vol. 29, No. 10, p. D-29 (Sept. 1957).

Dr. Paul B. Crawford is assistant director of the Texas Petroleum Research Committee at A & M College of Texas and a member of the Graduate Faculty. ■

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Suppliers' Parade

J. V. Holdam has been elected vice president of Dresser Industries, Inc., to supervise the firm's efforts in the field of electronics. He will be concerned primarily with supervising HST and SIE divisions of Dresser Electronics.

Continental-Emsco Co.'s industrial sales division has concluded arrangements to represent products of Besly-Welles Corp., cutting tool and gage division, and also of Wheel Trueing Tool Co.

Schlumberger Well Surveying Corp., expanding its logging and perforating services in the Permian Basin area, has opened a new office in Brownfield, Texas, managed by R. D. (Dick) Knapp.

Jones & Laughlin is now marketing a line of tanks and lease processing equipment manufactured by Maloney-Crawford Tank & Manufacturing Co., Tulsa. It includes bolted and welded tanks, heater treaters, glycol units, separators, filters, waterflood tank and dehydration units.

Aztec Manufacturing Co., Ft. Worth, Tex., is now a member of the Petroleum Equipment Suppliers Assn.

Harley Sales Co., Tulsa, celebrated its 25th anniversary recently with renewal of the company's contract as Oklahoma-Kansas-Texas distributor for Wisconsin engines.

Security Engineering, rock bit and oil tool manufacturer, has moved its Gulf Coast division and Houston district sales and service offices to the Mellie Esperson Building, Houston. Prior to acquisition of the new space, Security, a division of Dresser Industries, Inc., maintained these offices at its warehouse location.

Keenan Pipe & Supply Co. has been named distributor in Southern California, Arizona, Nevada and Colorado for ACF lubricated plug valves manufactured by the W-K-M Div., ACF Industries. Stocks will be maintained in Los Angeles, North Hollywood, San Bernardino, San Diego, Las Vegas, Tucson, Phoenix and Denver.

Sargent Engineering Corp., manufacturers of rod insert and rodless hydraulic oilwell pumps, has formed a sales district headed by R. C. Manning to accommodate increased business activity in the area of the company's store points at Bakersfield, Taft and Ventura, Calif.

Midland, Tex., sales and service offices and parts warehouse of Clark Bros. Co., Div. of Dresser Industries, Inc., has been moved to 1501 W. Industrial Boulevard. Headquartered there are Ben Stuart, sales engineer; D. E. Johnson, application engineer; A. J. Foster, parts salesman, and Bille Jo Hardin, district service manager.

Sondo Sales Co., Tulsa, has been appointed oil fields distributor of Power Chief Engines in the Mid-Continent area by the engine division of Nordberg Mfg Co., Milwaukee, Wis. Co-owners of Sondo are Frank C. Dossey and Marvin L. Thompson, both veteran field engineers and manufacturers' representatives.

Jones & Laughlin Supply Div., already an exclusive distributor for Major Engineering Co. products, has acquired manufacturing rights, designs and inventory of Major meter automatic custody transfer units, prover tanks, pressure switches, meter monitors and gage glasses.

Appointments and Promotions

Armour Industrial Chemical Co. — J. W. Misamore, advertising and sales promotion manager, Chicago.

Bucyrus-Erie Co. — Selden A. Stone, drill sales manager, South Milwaukee, Wis. He succeeds George D. Grayer, appointed sales manager of the company's newly formed Midwestern region.

Maloney-Crawford solves Another sour gas problem

TRANSWESTERN PIPELINE COMPANY
MEASUREMENT DEPARTMENT
SULPHUR DETERMINATION TEST REPORT

Company or Producer: TWPL Co. Date: 7-9-61
Field or Location: Contract Number:
Source or Reservoir: Stgny Field & Res. No.:
Well or Station Name: Estes Station Number:

Analysis of gas for H_2S, RSH, RSR & RSSR using Austin Titrator

Bromine titration results expressed in milliamperes generating current required to maintain a fixed level of free bromine in the generating cell during selective scrubbing processes. Gas flow set at 500 cubic centimeters per minute.

Test Data			
A.	Blank (filtered sulphur free gas)	.080	ma.
B.	Total Sulphur (unscrubbed gas)	1.036	ma.
C.	H_2S removed (selective scrubber)	.865	ma.
D.	H_2S & RSH removed (selective scrubber)	.393	ma.
E.	H_2S, RSH & RSR removed (selective scrubber)	.195	ma.
A^1	Blank rerun (if $A^1 \pm A$, rerun)	.080	ma.

Calculations	Sulphur Derivative		Equation	Grains/100 CF
	H_2S	Hydrogen Sulfide	.52 x (B-C)	.089
	RSH	Mercaptans	.44 x (C-D)	.216
	RSR	Sulfides	.90 x (D-E)	.178
	RSSR	Residual Sulphur	.50 x (E-A)	.048
		Total Sulphur		.531

Remarks:
Analysis By: DJ Roberts Witness by:
FORM TW-840

TRANSWESTERN PIPELINE CO.'S PROBLEM: 100 grains H_2S/100 CF in an 18 MM-SCF/D stream.

THE REQUIREMENT: Reduce H_2S to .25 grains/100 CF.

M-C' SOLUTION: An automated Sweet-A-Mine gas treating plant with ratio-rate control system.

THE RESULTS: H_2S content reduced to .089 grains/100 CF. The actual field report on the Sweet-A-Mine's performance is reproduced at right. Read it for proof that M-C can solve your sour gas problem.

CONCLUSION: If you have a sour gas problem, send it to M-C. You'll get an authoritative solution.

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Continental-Emsco Co. — Bobby J. Sims, manager of the Citronelle, Ala., store; Everitt L. Cole, division drilling equipment specialist, Houston; John E. McLean, division drilling equipment sales engineer, New Orleans; Thomas J. Bryant, division credit manager, Tulsa; Olaf S. Fry, district service manager, New Harmony, Ind.; George M. Cowie, district service manager, Casper, Wyo.

Hunt Tool Co. — Harley Guedry, branch manager, Corpus Christi, Tex.

Liberty Manufacturing Company of Texas — W. J. Armour, named to Houston area sales staff; John D. Ruff, transferred to San Antonio from Houston; J. C. Hawkins, transferred to Ft. Worth from Wichita Falls; Guy O. Denton, transferred to Dallas from Ft. Worth. Territory of R. H. "Tex" Martin, Shreveport, La. has been expanded to include Arkansas, Louisiana, Mississippi and Alabama.

Maloney-Crawford—Wf Roberts, named to application engineering staff, Tulsa.

National Supply Div., Armco Steel Corp. — R. B. Hill, wellhead sales supervisor for Southern region, transferred from Dallas to regional headquarters, Houston; Herman H. Vaughn Jr., wellhead sales representative, transferred from Odessa, Tex., to Lafayette, La.; Loyd H. Waites, wellhead sales representative, transferred from Lafayette to Hobbs, N. M.

Oil Well Supply Div., U. S. Steel Corp. — Robert C. Smith, district representative, Houston; J. D. Harbert, field representative, Wewoka, Okla.

Otis Engineering Corp. — Guy W. Gant, northern regional manager and product sales department manager.

Reed Roller Bit Co.—Roy A. Bobo, manager, sales engineering.

Technical Oil Tool Corp.—B. Ray Lummus, sales and service specialist, Shreveport, La., area; Arnold F. Koenig, sales and service specialist, Casper, Wyo.

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. . . it provides the hardness, impact resistance, and strength needed to withstand the shattering impact.

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4340 nickel-chrome-moly steel

Tensile Str. 1000 psi		Yield Str. 1000 psi	
As Rolled	192	As Rolled	147
Annealed	119	Annealed	99
Hard. & Temp.[a]	150[c], 220[d]	Hard. & Temp.[a]	130[c], 200[d]
Hardness (Brinell)		**Impact Str. ft.-lb.**	
		Izod. Hard.	
As Rolled	380	& Temp.	73[c], 16[d]
Annealed	240		
Hard. & Temp.[a]	310[c], 445[d]		

[a] Properties after heat treatment are based upon oil quench and 1-in. round bars. [c] Tempered at 1200° F [d] Tempered at 800° F

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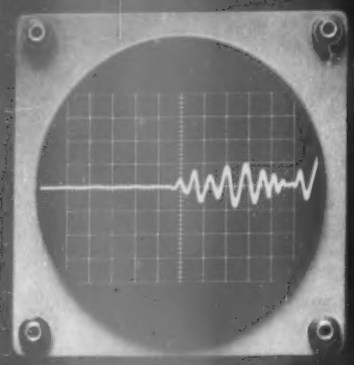
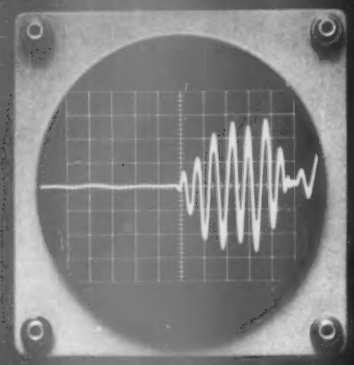
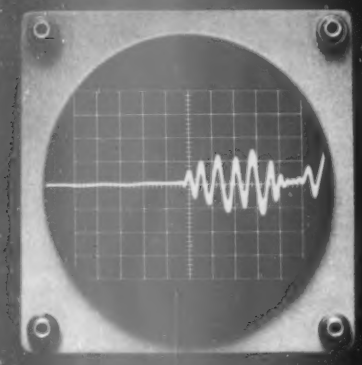


INTERVAL A — Heavily-fractured formation results in very low formation signal amplitude.



INTERVAL B — Unfractured formation results in normal signal amplitude.



INTERVAL C — Partially - fractured formation results in lower-than-normal formation signal amplitude.

WELEX FIRST AGAIN!

New Frac Finder locates best completion interval

The three intervals at left show different degrees of natural fracturing in the same limestone structure. Is there any question which interval you would select for completion?

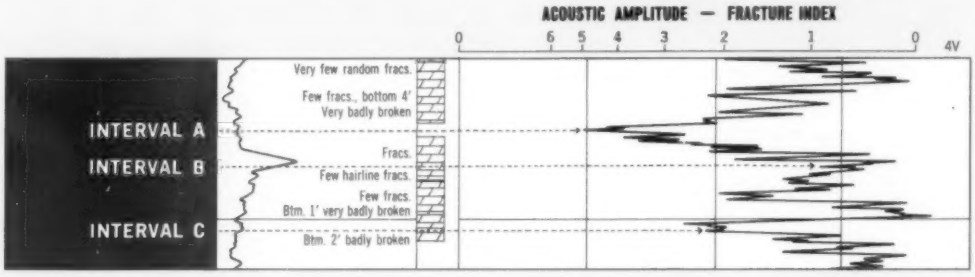
The heavily-fractured interval promises to be a star performer even though the matrix porosity and permeability may be low. But the non-fractured interval, though it's on structure, may not even make a well. This means that an accurate method is essential for determining if the fractures are open. So the only question is—**How do you find the most heavily fractured interval?**

The Welex Fracture Finder, with a direct-reading Fracture Index printed right on the log, does it simply with a single curve. The Fracture Finder (or Acoustic Amplitude Log) directly measures the formation signal amplitude, accurately locating all open natural fractures within perforating range of the well bore.

The Fracture Index is based on engineering data obtained by Welex in a full-size test pit containing natural limestone blocks. It gives an easily read quantitative measure of the degree of fracturing in each zone.

In the past, cycle skipping on acoustic velocity logs sometimes has been used in an attempt to find fractures. The Welex Fracture Finder, with its Fracture Index, makes this "trial and error" method of fracture location obsolete.

The Fracture Finder shows both vertical and horizontal fractures and gives you a complete picture on the first trip



—showing plainly where the fractures are and **the degree of fracturing.**

In fractured formations the Fracture Finder measures the reduction in the amplitude of the acoustic signal caused by reflections of energy at any interface where there is a large density change. At such interfaces a portion of the signal is reflected and a lesser amount reaches the receiver than if the fractures were not present.

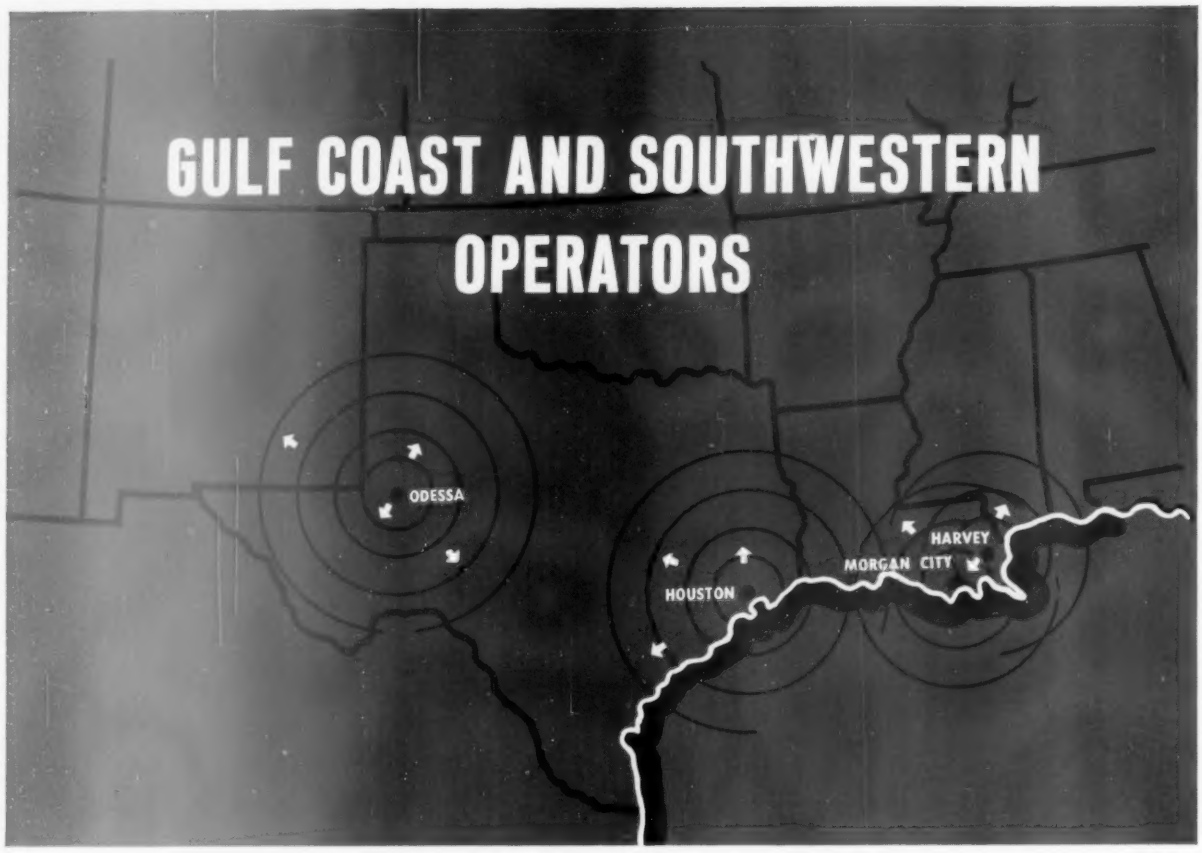
On your next well, call Welex. The Welex Fracture Finder Acoustic Amplitude Log is fully tested, field proved and ready to work for you.

COMPLETE WIRELINE SERVICES — Welex

WELEX

A Division of Halliburton Company

General Offices: 1728 Old Spanish Trail, Houston, Texas



Plastic Applicators' four strategically located pipe-coating plants can help you cut tubing inventories, speed coated-tubing deliveries, and reduce freight costs for both new and used tubing.

Many operators now keep their capital investment in tubing inventory low by purchasing locally from supply stores or mill stock, in quantities to meet only current needs. Usually an operator's inventory can be smaller if he can have his tubing coated quickly at a nearby plant. Such minimum-investment purchasing is especially practical for most Gulf Coast and Permian Basin operators because four conveniently located Plastic Applicators' plants at Harvey and Morgan City, Louisiana, and Houston and Odessa, Texas, give them quick delivery.

The strategic locations of these plants also help operators keep their freight costs low. (An added convenience is the full range of in-plant inspection services for new and used pipe offered by Plastic Applicators' Pipe Inspection Division. Money-saving combination coating-and-inspection rates are available)

Call a nearby Plastic Applicators plant or sales office today for the complete story on how Plastic Applicators' conveniently located plants and on-time deliveries can help you cut costs.

LOCATIONS:

Main Office: *7020 Katy Road, P. O. Box 7631, Houston, Tex., UN 9-3611. Plants: Harvey and Morgan City, La. Houston and Odessa, Tex.*

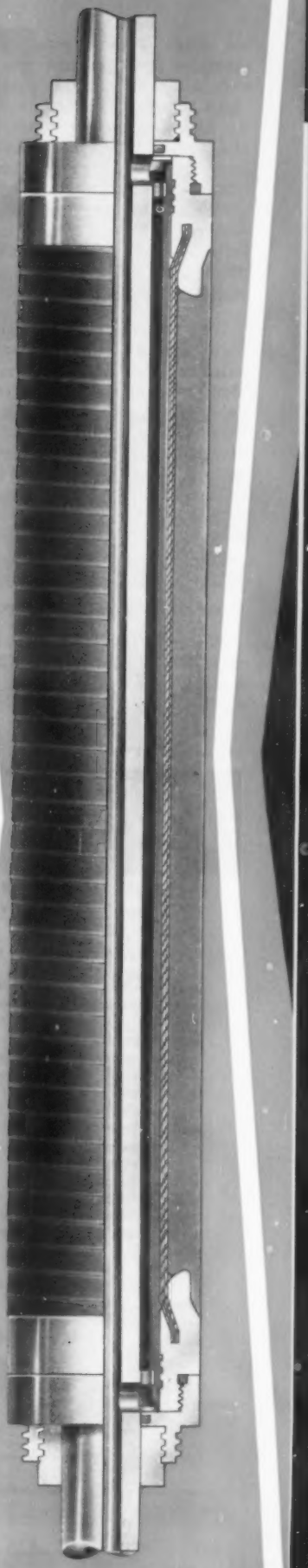
Sales Offices: *Midland and Corpus Christi, Tex.; Hobbs, N.M.; Tulsa, Okla.; Houma, Lafayette, New Orleans, and Shreveport, La.; Jackson, Miss.*

BETTER COATINGS THROUGH RESEARCH

PLASTIC APPLICATORS, INC.

LYNES

INFLATABLE SEALING ELEMENT



A Basic Tool for Modern Oil Recovery

Sealing in open hole or in pipe with an inflatable element is a simple principle, yet the LYNES Inflatable Sealing Element and packer took ten years of extensive engineering development and testing before this principle became an effective tool for the oil industry.

Since 1950 LYNES Inflatable Sealing Elements have been tried and proven in thousands of wells and are recognized throughout the industry as The Inflatable Packer.

The LYNES Wildcat Straddle Tester using the inflatable sealing element has opened many fields to oil production that would otherwise have been lost by providing a low-cost method for treating and testing questionable open hole zones without setting casing. By the same token, money has been saved by proving holes dry without expensive completion costs.

The LYNES Production-Injection Packer featuring the inflatable element was made available to the oil industry as a sale tool in 1958 and has been proven as a safe and economical solution to many production or injection problems.

LYNES single and straddle element tools are used for treating and testing multiple zones in casing and/or open hole, for making formation fracture impressions, for locating thief zones or casing leaks and for many other uses. In addition LYNES inflatable elements are used on the LYNES INFLATA-TEST Units providing a safe, positive pressure test of tubing after it has been made up to lower into the well.

See how LYNES can help you in your drilling and production operations, call your LYNES representative soon.

LYNES, INC.

7042 LONG DRIVE • HOUSTON, TEXAS

LYNES

BRIGHT NAME IN THE OIL PATCH

Inflatable Sealing Element Packers

D & P Equipment

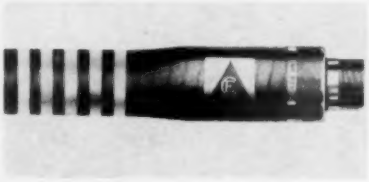
Bellows-Type Expansion Joint

New bellows-type expansion joint, rigid against all movement except axial and creating minimum friction along guiding surfaces, is offered in externally and internally guided models. On request, company will manufacture a joint that is both internally and externally guided. Specifications are given in Bulletin 61.65. *ADSCO Div., Yuba Consolidated Industries, Inc.*

Circle number (1) on reply card.

Hose Has More Reinforcing

New 5-band rotary hose has 34% more wire reinforcing (based on size of wire) than 3-band hose, assuring longer life and added safety with all fluids, air and natural gas. Four plies of individual, fully rubber-coated wire strands are set by electronically controlled equipment to a precise tension; thus all wires carry an equal share of the load for maximum strength. This construction resists mishandling that may



result in kinking or doglegging, yet retains needed flexibility. Neoprene cover resists corrosive muds, gases, foams, heat, abrasion and chemical attack. White strip running length of the 5-band makes possible visual check to see that hose is not twisted in derrick. Hose, which comes in standard sizes of 55 and 60-in. lengths and 3 and 3½-in. ID, exceeds

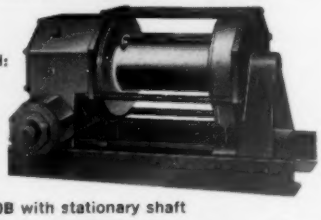
Koenig INTRODUCES A REVOLUTIONARY NEW TYPE OF HEAVY-DUTY POWER WINCH

FEATURING TORQUE TRANSMISSION DIRECT FROM GEAR SPIDER TO DRUM . . . NO KEYS TO SHEAR

20,000 pounds safe hoisting capacity

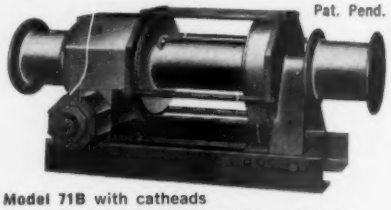
Outstanding features of the NEW KOENIG WINCH:

★ Drum torque load is NOT transmitted by drum shaft . . . no keys to shear . . . torque is transmitted direct from gear spider to drum by means of multiple-splined collar in gear housing.
★ Entire unit, including safety brake, is lubricated by the oil-bath principle, with a generous supply of oil to prevent overheating.
★ Engineered to use standard lubricants available throughout the world.
★ Multiple-plate automatic safety brake, running in oil with one-direction clutch, is easily adjusted or released.
★ Accurate drum clutch position indicator.
★ Gear ratio — 38:1.
★ Nickel-bronze alloy worm gear. Hardened and ground worm mounted on Timken roller bearings.



Model 70B with stationary shaft

Pat. Pend.



Model 71B with catheads

THIS ADVANCED-DESIGN KOENIG WINCH IS RECOMMENDED FOR OIL-FIELD EQUIPMENT, PUBLIC UTILITIES, HEAVY WRECKERS, CONSTRUCTION, AND OTHER HEAVY-DUTY JOBS.

Koenig winches have served the industry with dependable pull and hoisting power since 1934. Koenig also builds a complete line of utility and service bodies.

Koenig IRON WORKS, Inc.

P. O. BOX 7726, DEPT. W • HOUSTON 7, TEXAS

NEW LOW-COST, EFFICIENT

CHEMICAL PUMP

for wells with corrosion, scale or wax conditions

The new Pacific Chemical Pump will deliver 5 to 150 gallons per day. Once it is set, the injection of treatment solution is constant.

Precision made of high quality materials to safely withstand working pressures to 1000 P.S.I.

Write, Wire or Phone For Details

Pacific PERFORATING CO., Inc.
Torrance, California
Telephone SPruce 5-3269

API pressure requirements for Class C rotary hose. *Continental-Emsco Co.*

Circle number (2) on reply card.

Lease Tank Mixer Offered

New Model 55 lease tank mixer, developed to resuspend paraffin in 500 through 3000-bbl crude tanks, is particularly suitable where it is necessary to keep tank in continuous service. Right angle drive with vertical motor is used for compactness. Gear box swings to one side for easier repair of seal. Tank contents can be sealed off at any time to permit replacement of mechanical seal. Entrance angle of shaft into tank can be adjusted 30 deg to either side of center line of the tank, or a total of 60 deg. This permits complete sweeping of tank bottom to provide removal of all paraffin deposits. Units are normally mounted on cover plates to match cleanout doors and are delivered ready for bolting on. No fitting or welding is required. Bulletin SL-55 supplies engineering data. *Jensen Engineering Co.*

Circle number (3) on reply card.

Two New Rotary Hoses

Two new types of rotary hose are designed with working pressures to meet highest pressure capacities of present day pumps. S-7500 Super Long-Life is for use with working pressures to 4000 lb, while S-10,000 Ultra Long-Life was developed especially for rugged, fast, high pressure drilling where working pressures often exceed this figure. It is pre-tested at 10,000 lb. All cables are wound at same angle, under same tension, so each cable will take its share of pressure load. This eliminates weak points, knotting and localized expanding. Construction is Synplastic throughout. Both hoses have Barney coupling and Goodall safety clamp and are covered by one-year guarantee. *Goodall Rubber Co.*

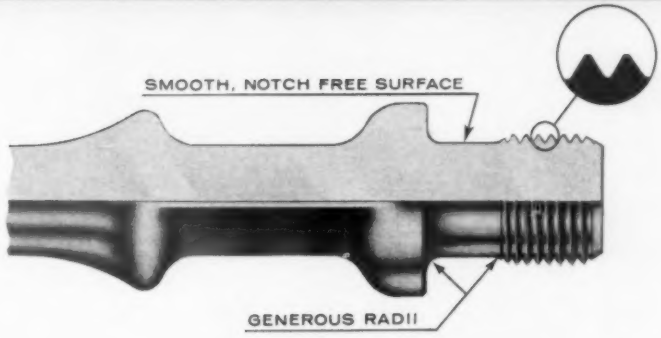
Circle number (4) on reply card.

Valve Eliminates Wet Plugs

New safety valve controls unloading of drill pipe, eliminating need for wet plugs when running a drill stem test. Applicable in tests where water cushion in drill pipe is used, valve will save considerable rig time now lost when using wet plugs. The full-opening valve consists of a spring-activated flapper valve for closing and opening and a sleeve which keeps the flapper in an open position until activated by the operator. Device is set mechanically by pipe manipulation and a pin and J-slot mechanism in areas where possibility of trapping large quantities of fluid is present, safety valves can be placed at intervals in the drill string. Positive in its action, valve is equipped with bleed-off port which allows formation fluid to be safely discharged into slush pits away from rig. *Johnston Testers, Inc.*

Circle number (5) on reply card.

NEW! AT AXELSON-GARRETT



SUCKER RODS

WITH UNDERCUT PIN AND ROLLED THREADS

Greater fatigue strength. Smooth, uniform burnished threads. Reduced stress concentration effects. Improve your performance capabilities by installing the new Axelson Rods with rolled threads and stress engineered undercut.

Rolling the threads leaves the roots in compression — in effect preloaded for prolonged fatigue life. The thread form is consistent, with a smooth burnished finish free of tears and cutter marks. The result? Greater consistency in pin preload make-up!

The stress engineered long undercut removes the imperfect threads with their built-in high stress concentration effect. The longer length increases the ability of the pin to maintain original pin preload. The result is a joint capable of increasing the already outstanding performance of Axelson Rods.

Check with your Axelson-Garrett or Jones & Laughlin Supply representative before you order your next string . . . you will save money by specifying this superior new pin. Call him today!

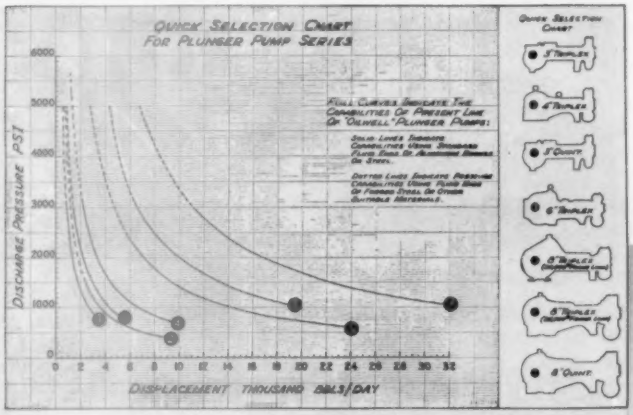
USI Axelson-Garrett
A DIVISION OF U.S. INDUSTRIES, INC.
"Products Designed to Give Oil a Lift" Sales Headquarters: Houston, Texas

The "OILWELL" string...

PRODUCTS SERVICES STORES

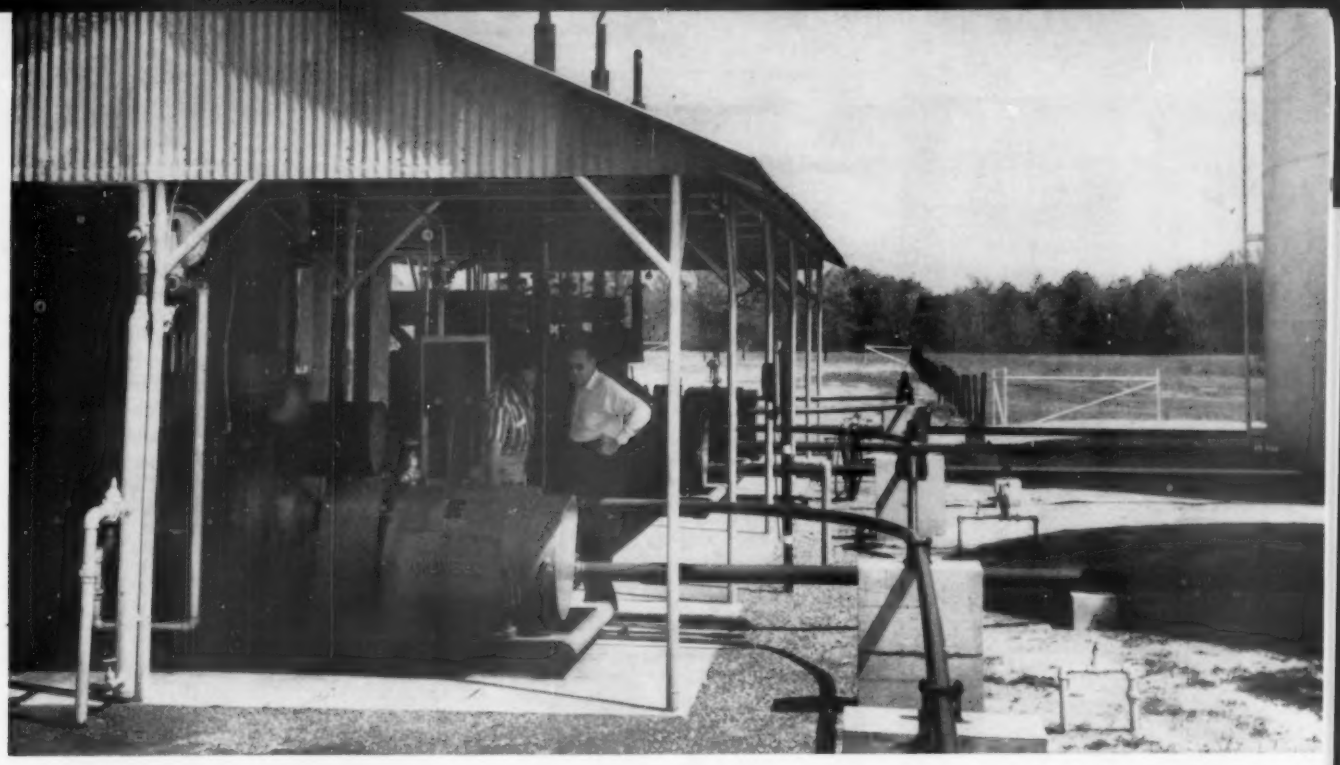
How to take the guesswork out of plunger pump selection

A mistake in horsepower, capacity, pressure requirements or suction and discharge piping arrangements can be costly. Here's a simple, nearly error-proof way of sizing the best plunger pump for your fluid-injection use—get your copy of "Oilwell's" new "Plunger Pump Selection Manual" without delay.



The manual describes in detail "Oilwell's" complete line of seven primary pumps. Volume-pressure range curves make it a simple matter to pick the pump that's right for the job. Picking plunger sizes is simple, too, because you'll find complete performance data for all plunger sizes available with each size pump. The selection manual also contains a wealth of other information including how to apply the pumps and how to size and arrange suction and discharge piping.

Write on your company letterhead for a free copy of "Oilwell's" Manual M29-1060. It's one of our ways of making sure that when you buy "Oilwell" equipment, you get a lot more than our product.



Why "Oilwell" waterflood pumps take it lying down

The pumps in the picture are operating in the New Odom field, and one of them has been pumping 24 hours a day for *eight months* without stopping. Naturally, it's an "Oilwell" pump and its design has a lot to do with its performance.

Every "Oilwell" plunger pump is designed horizontally for eight good reasons: *Low suction* . . . lowness of suction and discharge lines means maximum utilization of suction head and simplifies piping layout. *Less deadweight on crankshaft* . . . eases bearing loads, minimizes vibrational stress in frame and piping. *Simpler thrust transmission* . . . eliminates overhead yoke and pull-rod assemblies. *Cleaner installations* . . . any leakage is confined to frame cradle by gravity. *Natural valve motion* . . . fewer parts needed. *Low center of gravity* . . . reduces vibration that can cause piping stress and fatigue. *Safer maintenance* . . . does away with ladders and neck-craning. *Easier maintenance* . . . greater accessibility.

There's a wide selection of top-performing "Oilwell" Triplex and Quintuplex pumps for waterflood applications, LPG Flood, Pressure Maintenance, Formation Fracturing, Acidizing and Cementing, Salt Water Disposal, or you name it. Whatever your requirements, call on your "Oilwell" representative for complete information and help in the planning stage.

USS and "Oilwell" are registered trademarks

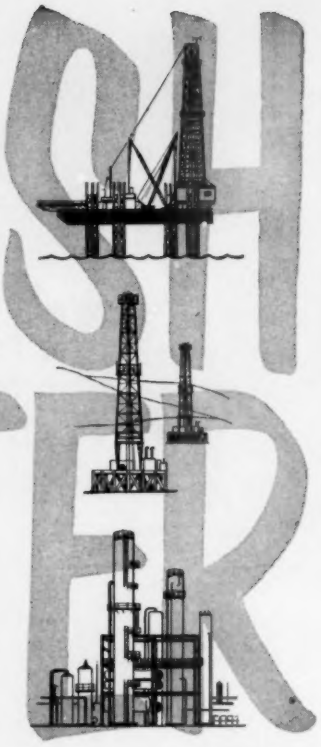
Off the shelf

It's all on the shelves in an "Oilwell" store, everything from subsurface pumps to mud gauges. Whatever you need in the way of production or drilling equipment, and whenever you need it, your nearest "Oilwell" store can take it off the shelf, load it, and it's no more than a short trip from your lease. That's because there are "Oilwell" stores, sales offices, warehouses and conversion centers (*and* pump shops) located *throughout* the oil country. If you're near oil, you're near an "Oilwell" store.

USS Oil Well Supply Division of United States Steel

Executive and Export Offices: Dallas, Texas

FRESH WATER

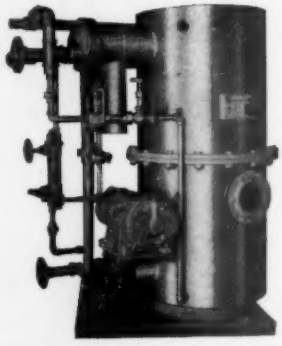


FUEL-FREE . . .

FROM SALT

OR BRACKISH

WATER



Wherever there is a supply of salt or brackish water, AMF-Maxim Aquavap heat recovery evaporators provide a practical, economical way of producing fresh water of purity exceeding U.S. Public Health Service requirements. These compact evaporators operate on engine jacket water or any other hot water source, and thus add nothing to existing fuel cost. They are low in initial cost, inexpensive to maintain and simple to operate, and are delivered as a complete packaged unit ready to install. Capacities range from 150 to 12,500 gallons per day of fresh water.

Write Dept. P for detailed information, or call our Engineering Department (Hartford, CHapel 2-2281).

AMF MAXIM EVAPORATOR DIVISION
American Machine & Foundry Company
WATERFORD, CONN. • Branch, DENVER, COLO.

Represented by THE J. B. BEAIRD COMPANY
Shreveport, New Orleans, Tulsa, Midland, Houston, New York

Data Gathering System

Model S-3100 portable data gathering system, which records analog test data for direct entry to a digital computer, provides full data processing capabilities of large-scale, multi-rack, fixed installations. Weighing less than 130 lb and packaged in two aluminum carrying cases, S-3100 will accept up to 100 analog voltage inputs and record them in exact digital format without intermediate transcription. The transistorized system is available in variety of specified sampling rates and computer-formatted digital outputs. *Systems Div., Epsco, Incorporated.*

Circle number (6) on reply card.

Seismic Detector Introduced

New EV-12 very low frequency seismic detector is designed for long range seismic refraction work and crystal studies. Weighing just 3 lb, it utilizes inclined spring supported beam suspension principle more commonly used in earthquake seismographs. Specifications include: coil resistance, standard-500 ohms (available from 60 to 4000 ohms); tilt angle within limit of 2½-deg "bullseye bubble;" natural frequency, 1.0 cps, adjustable ±0.25 cps; coil excursion, ±⅛ in. Can be roughly handled when caged with thumb screw clamp. *Electro-Technical Labs, Div. of Mandrel Industries, Inc.*

Circle number (7) on reply card.

New Pump Jacks Announced

Pump jacks in new Series E come in unit sizes 1, 2, 4, 5, 6, 7 and 8. Gears in all gear reductions are of nodular iron. Cranks are of split hub type, and are full floor clearance. Stroke adjustment is obtained by varying position of upper pitman bearing on the walking beam. Counter-balancing is accomplished by use of counter-weights installed on the walking beam. *Jensen Bros. Mfg. Co., Inc.*

Circle number (8) on reply card.

Quik-Sert Safety Head

Quik-Sert safety heads described in Bulletin 77-540, nests inside studs of standard ASA flanges and contains a rupture disc to protect a vessel or system from over pressure. At preset pressure, disc will rupture to prevent pressure damage. Unit may be installed underneath a safety or relief valve where absolute seal is

obtained. This eliminates normal vapor losses through the valve. Preassembly of rupture disc away from location affords many installation conveniences. Quik-Sert isolates valve from process, thereby reducing valve maintenance requirements. *Black, Sivalls & Bryson, Inc.*

Circle number (9) on reply card.

Packing Improves Water Treatment

A plastic packing for efficient water treatment is being produced by Dow Industrial Service. Called Dowpac 20A, the material consists basically of individual sheets, corrugated in two directions, measuring approximately 36 x 21 in. Configuration of the sheets is designed (1) to distribute falling liquid wastes in thin films over large surface areas so that maximum aeration is obtained; (2) to provide a high percentage of void space for natural-draft ventilation and waste flow; and (3) to provide large surface areas to which active biological slimes can adhere. The material is inherently light in weight and is completely self supporting. *Dow Chemical Company.*

Circle number (10) on reply card.

New Rock Bits Introduced

Two new rock bits, the H 3 and HW 3, are now available in both regular and jet types. HW 3 bits have heavily hard-faced gage webs for maximum resistance to gage wear. They will hold gage better than the H 3 in chert, chat, quartzite, pyrite, granite, dolomitic and quartzitic sand rock and other hard abrasive formations where gage is a problem. H 3 bits drill faster than HW 3 in formations where gage is not a problem. They have short, closely spaced teeth and large bearings for carrying the high loads required for crushing-chipping action to penetrate hard sandy limestone, cherty limestone, dolomite, quartzite chert, chat and granite formations. *Globe Oil Tools Co.*

Circle number (11) on reply card.

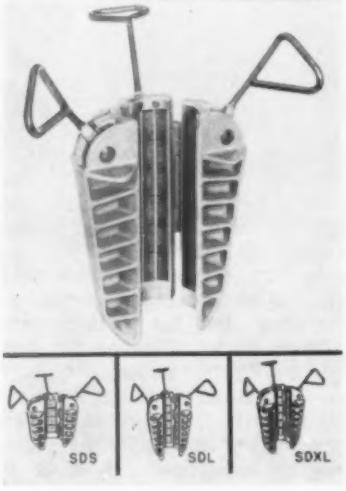
Feed Systems for Oilfields

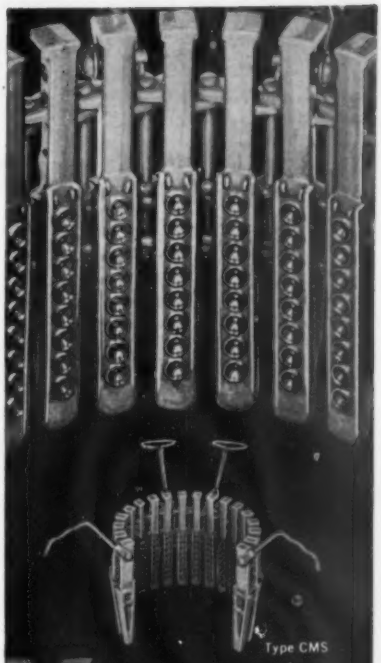
New corrosion-resistant systems for feeding water treatment chemicals and corrosive liquids into oil wells and oilfield water systems employ a positive displacement, diaphragm-type pump with capacities of 2.4 to 24 gpd at zero psi to 20 gpd at 100 psi. Pressure rating is from 20 in. vacuum to 100 psi. Model P-3, for feeding of water treatment chemicals, has clear plastic (tyril) pump head and rubber, nylon-reinforced diaphragm. Model P-4, for feeding of acids and other corrosive liquids, is equipped with penton pump head and viton, nylon-reinforced diaphragm. Both systems include a 55-gal, self-supporting, polyethylene tank of ⅛-in. thickness. *Oilfield Div., Hagan Chemicals & Controls, Inc.*

Circle number (12) on reply card.

Slips Feature High Strength

Newly engineered buttress structures enable slip sections to withstand greater axial and transverse loads in a new line of Varco rotary slips. This increase in strength has been achieved without an increase in weight. Case-hardened inserts are designed with more total line contact than other inserts. Inserts can be replaced with circular buttons for rotating drill pipe. Type SDS-short is for loads up to 180,000





Varco

CASING SLIPS & BUSHINGS

...make all casing operations faster and simpler. Cementing baskets, scratchers, and centralizers pass through the solid Varco Bushing easily. And because this bushing fits into the main drive square of your rotary table: you can rotate your string at will. Varco Multi-Segment Slips with circular buttons or inserts hold casing safely and securely. Add simplicity and economy to casing programs.

Write for details

Type CU

ABEGG & REINHOLD CO.
2533-41 EAST 26TH STREET
LOS ANGELES 54, CALIFORNIA
MIDCONTINENT OFFICE: HOUSTON, TEXAS

LOWER LIFTING COSTS

In Both Primary and Secondary Recovery, You Can Depend on

THOMPSON ROD PUMPS

Solve down-hole pump problems by standardizing on Thompson Rod Pumps—they run longer, more economically. You can count on reliable performance!

OVERSIZE PUMPS:
1 5/8" Bore for 2" Tubing,
2 1/8" Bore for 2 1/2" Tubing.

STANDARD:
1 1/16" 1 3/4"
1 1/4" 2"
1 1/2" 2 1/2"

Thompson PUMP COMPANY

DRAWER 591 • OKMULGEE, OKLA.

lb. Type SDL-long is recommended for loads over 300,000 lb. The SDXL has a special back that is 45% longer than API specifications and when used with extended taper bowls, gives 1½ times more backed-up gripping area than conventional slips. *Abegg & Reinhold Company.*

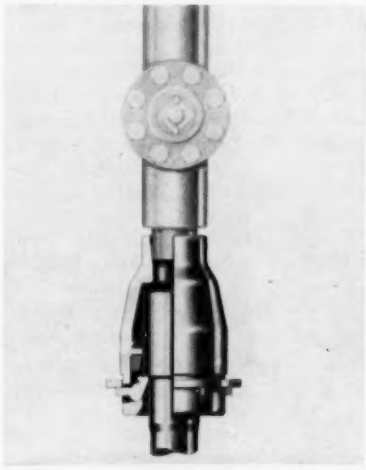
Circle number (13) on reply card.

Strong Joints in New Tubing

A new Acme-thread tubing features non-upset, high strength joint for deep wells and multiple completions. Design gives maximum clearance with joint strengths considerably above yield strengths of tubing body. Dimensions have been reduced from standard Acme thread in 4:3 ratio. Threads have been run out completely, extending them on a constant taper to the OD surface of tubing. Increasing number of threads has added strength and leak resistance. The full thread run-out has an 8-pitch thread, 0.045 in. deep, that provides 17.5 perfect and 11.5 imperfect threads. The 8½-in. coupling is available with beveled ends for use on multiple completion wells. *Pittsburgh Steel Co.*

Circle number (14) on reply card.

Shutoff Coupling Controls Tubing



Regan Forge & Engineering Company has added a new fast shutoff coupling to their line of blowout prevention equipment. Extremely light and hand portable, the aluminum alloy coupling, with a valve attached, is kept on the rig floor when running or pulling tubing. If the well should start to blow, the fast shutoff coupling is quickly dropped over the top of the tubing string, automatically latching on and sealing off around the coupling. The well can then be controlled with the valve. *Regan Forge & Engineering Co.*

Circle number (15) on reply card.

High Performance Shaped Charge

New NCF II shaped charge, detailed in brochure, is said to exceed in performance any shaped charge retrievable casing perforator previously available. Advantages include greater penetration, improved well flow index and enlarged hole diameter. As with the earlier NCF charge, objectionable metallic carrots are eliminated. NCF II can be used in Koneshot perforators in standard sizes for 5½-in. and larger casing and also in a new superior-performance 3⅛ in. OD gun for use in 4½-in. casing. *Lane-Wells Co., Div. of Dresser Industries, Inc.*

Circle number (16) on reply card.

Literature

Wellhead Equipment

The Norris Hinderliter line of wellhead equipment is completely displayed in a 28-page catalog. Schematic drawings and tabular specifications describe tubing heads, casing heads, dual-string hangers and other wellhead equipment. Also included are tables of standard tubing and casing dimensions. *W. C. Norris, Manufacturer.*

Circle number (17) on reply card.

Respiratory Protection

Interchangeable respiratory protection provided with M-S-A Dustfoe and Gasfoe is the subject of an illustrated 4-page folder. It shows how one facepiece can be used with a variety of filters and chemical cartridges to protect against dust concentrations, radioactive particulate, metal fumes, organic vapors, acid gases, ammonia and other airborne hazards. Back cover gives guide to selection of correct filter. *Mine Safety Appliances Co.*

Circle number (18) on reply card.

Control Valves Manual

A 20-page specifying section containing information necessary for selection of a control valve is one of the features of an illustrated. easy-to-read, 64-page manual on Fisher pneumatic diaphragm and piston actuators and valve body assemblies. The manual also includes: discus-

with faith in the oil industry's future . . .
GARDNER-DENVER MAKES THE NEWS

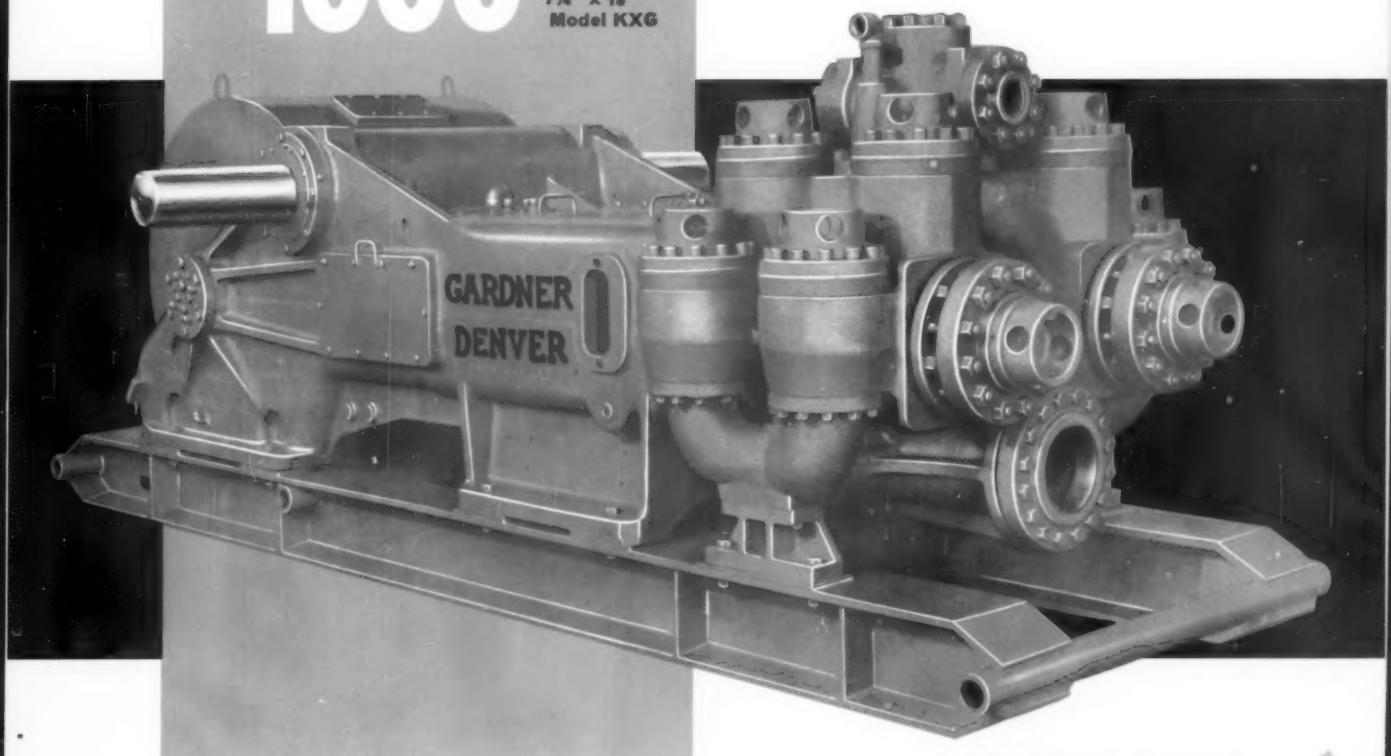
Gardner-Denver KX power pumps for mud service

TWO MODELS

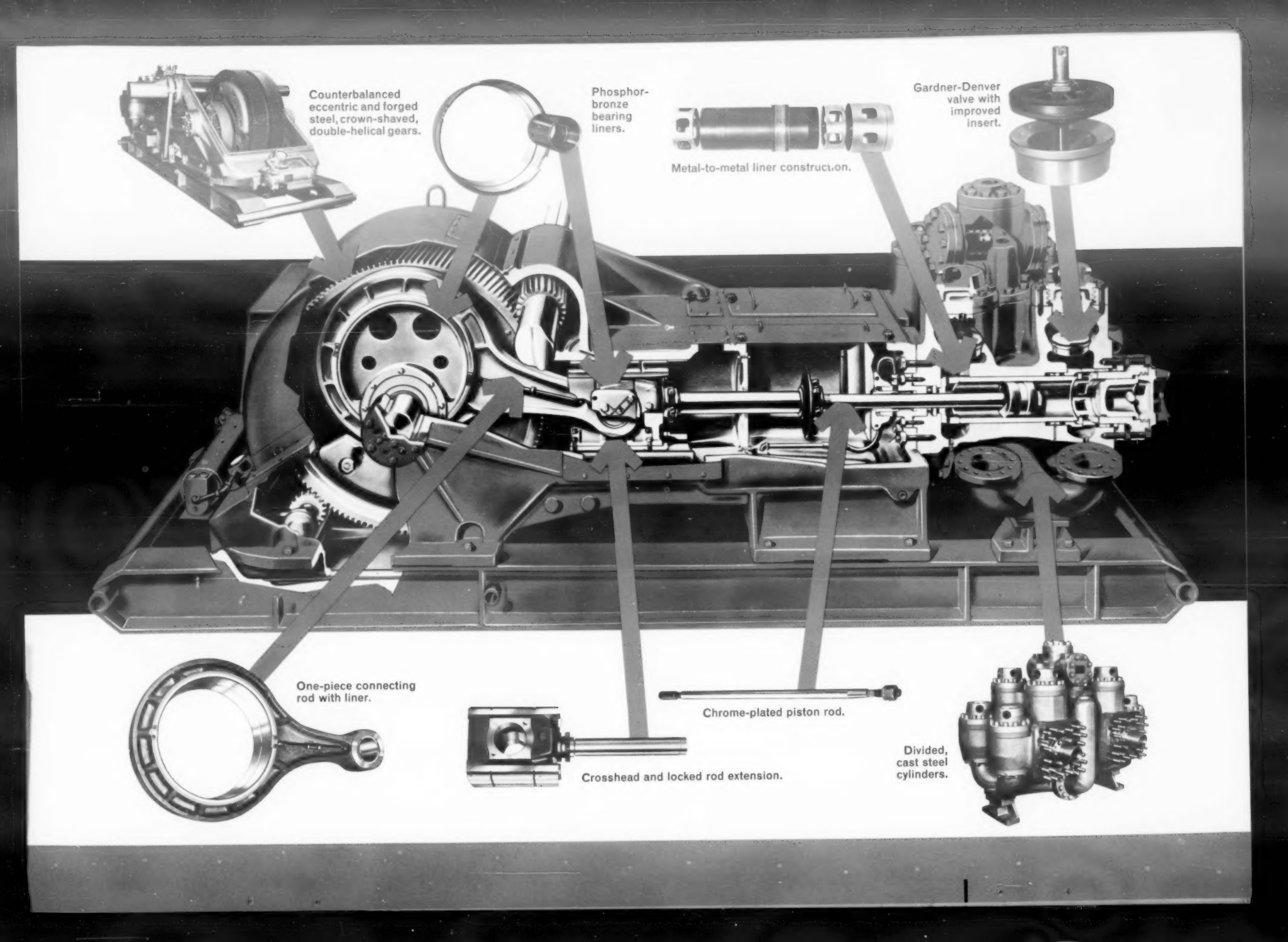
700 hp
7¾" x 16"
Model KXF

1000 hp
7¾" x 18"
Model KXG

- Steel Fluid End
- Metal-to-Metal Liners
- Gardner-Denver Valves
- Threaded Heads and Valve Covers
- Counterbalanced Eccentric
- Dual Lubricating Pumps



it's what's inside that counts


Counterbalanced eccentric and forged steel, crown-shaved, double-helical gears.
Phosphor-bronze bearing liners.
Metal-to-metal liner construction.
Gardner-Denver valve with improved insert.
One-piece connecting rod with liner.
Crosshead and locked rod extension.
Chrome-plated piston rod.
Divided, cast steel cylinders.

New Gardner-Denver KX mud pumps provide outstanding hydraulic service for the modern rotary drilling rig. Note these quality construction features which put the new KX pumps far ahead in performance, reliability, ease of maintenance and the all-important ability to make on-location repairs.

compare

the New Gardner-Denver KX Pumps with any other mud pump in the field

Fluid end features

- Divided cylinders of high-strength cast steel.
- Metal-to-metal liner construction prevents liner movement. Liner packing is retained by a separate independent spacer, gland, and adjusting nuts.
- New Gardner-Denver fluid valves have improved insert to seal fluid flow, and steel face to support pressure. Also available with regular rubber insert. Renewable valve seats and upper guides.
- Threaded valve cover plates save time on every valve inspection or valve change.
- Threaded cylinder heads facilitate liner changes.
- Streamlined suction manifold equalizes fluid flow to all valves. Provided with pulsation dampener and flanged intake.

Power end features

- Famous Gardner-Denver eccentric drive, counterbalanced for smooth operation; forged steel, crown-shaved, double-helical gears.
- Centrifugally cast bronze sleeve bearings provide large bearing areas to absorb high plunger loads.
- Double extended jackshaft, carried on roller bearings, permits driving from either side.
- All working parts receive a generous supply of lubricating oil under pressure from two direct driven positive-displacement pumps.
- One-piece connecting rods have no bolts to loosen or fail.
- Pistons and rods can be changed without opening power end. Piston rod extension, locked in cross-head, extends through oil-stop head.

For complete specifications, write for Bulletin KX-1.

GARDNER-DENVER Since 1859

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

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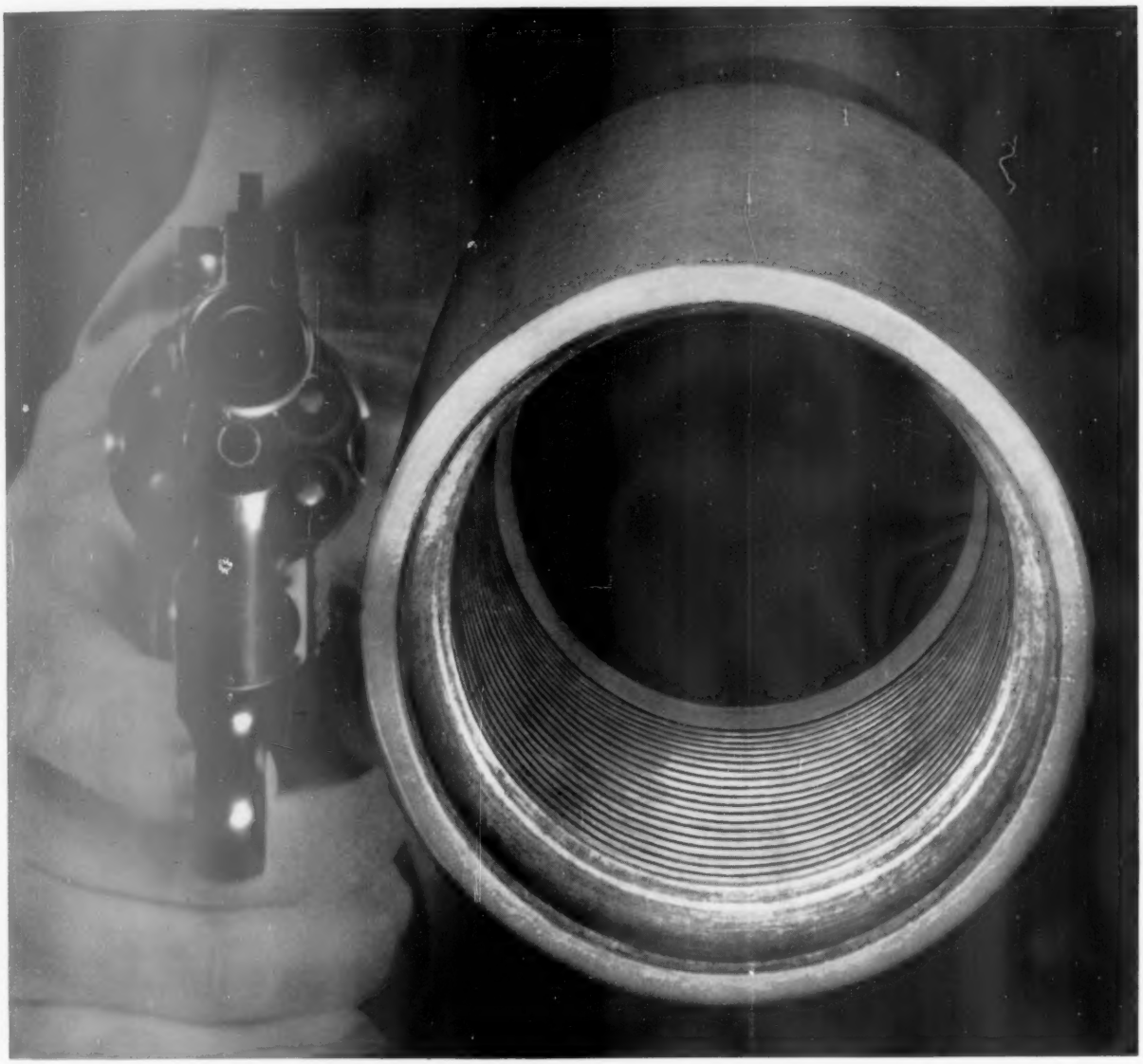
Offices: Buenos Aires, Argentina; Artarmon, N.S.W. Australia; Brussels, Belgium; Rio de Janeiro, Brazil; Santiago, Chile; Barranquilla, Colombia; Lima, Peru; Ndola, N. Rhodesia; Salisbury, S. Rhodesia; Johannesburg, Transvaal

LITHO IN U. S. A.



They've both got a "business end"

In a pistol it's the muzzle . . . and in oil country tubular products it's the threaded connections. This is a vital area that helps determine performance "life-or-death." And it's here that CF&I Seamless Casing and Tubing really has what it takes for success.

Every thread is cut by modern machinery – then checked by a contour microscope that determines absolute accuracy of angle and form. No weak links survive to render hundreds of feet of pipe worthless.

In short, CF&I Casing and Tubing holds up on the job, but never holds *you* up on the job. It's available in sizes from 2⅜" to 9⅝" O. D. and meets API specification STD 5A. Ask your CF&I salesman for complete details.

The Colorado Fuel and Iron Corporation
Denver • Oakland • New York
Sales Offices in Key Cities

sion of valve body and trim materials; description of various styles of valve plugs; pressure-temperature ratings; maximum pressure drop tables; performance data including frequency response; and accessories, such as valve positioners, handwheels, and electro-pneumatic transducers. *Fisher Governor Co.*

Circle number (19) on reply card.

Compact Gages Described

Compact, easy-to-read Rockwell-Republic V5 gages for indicating draft, pressure, differential gas pressure and temperature and pneumatic impulses from transmitters are described in a 12-page bulletin. *Republic Flow Meters Co.*

Circle number (20) on reply card.

Inhibitor, Handy Table

Two new technical data sheets have been issued—TDS-6161-917 describing Well-Foam 917 corrosion inhibitor used in "gasified" systems; and TS-61561-FAC, a handy table of concentrations for preparing foaming agent-water mixtures in the field. *Well Completions, Inc.*

Circle number (21) on reply card.

Data On DI Pipe Fittings

An illustrated 12-page catalog presents a complete line of ductile iron pipe fittings — describing strength, ductility, impact resistance, low temperature transistion, corrosion resistance, and listing typical applications. Shown are ductile screwed fittings with ratings from 300 to 2000 psi, pipe lock couplings for 400 and 800 psi; flanges and flanged fittings in the 150 and 300 lb class; and hexagon bushings and plugs. *The Kuhns Bros. Co.*

Circle number (22) on reply card.

Sonic Oil Well Pump Report

A 14-page engineering description and evaluation of the Sonic oil well pump prevents 12 illustrations. "The Sonic Oil Well Pump Report" presents an evaluation of operational mechanics as applied to normal and problem wells (sand, mud, paraffin, gypsum, corrosion, gas, volume). Case histories are incorporated. *Johnston Testers, Inc.*

Circle number (23) on reply card.

Dri-Flo Orifice Meters

A bulletin details the new line of American Dri-flo orifice meters for differential pressure measurement. Designed for use where mercury is undesirable, they are available in indicating, recording, controlling and telemetering models with working pressures from 1000 to 5000 psi and differential ranges from 0-20 to 0-400 in. w. c. *American Meter Co.*

Circle number (24) on reply card.

For Selective Acidizing

Water-gel Temporary Plugs are slugs of gelled water injected before and between batches of acid to shut off more permeable zones temporarily so that the benefits of acidizing treatment may be extended to less permeable zones. Where it is used, its advantages, physical properties, how it is used, and case histories are outlined. *Dowell, Div. of The Dow Chemical Co.*

Circle number (25) on reply card.

Traveling Block Brochure

A full line of traveling blocks ranging from 125 to 550-ton capacities are featured in a colorful brochure. Cutaway drawings show internal construction. The blocks introduce the Trim-True design. Up to 2000 lb of weight has been added without increasing outside dimensions. *Gardner-Denver Co.*

Circle number (26) on reply card.

"Triple Threat"
TO SUCKER ROD FATIGUE

1. JONES SUCKER RODS
2. JONES UNDERCUT PINS
3. JONES ROLLED THREADS

Rolled threads are stronger at the point where most pin failures originate . . . steel fibers and grain are rearranged to follow the thread contour, providing a dense structure at the critical thread root. Sucker rods with rolled threads make up tighter and stay tight because there are no high spots to beat down and cause the joint to loosen.

Undercutting the pin shank further increases fatigue resistance by eliminating the run-out thread and improving the elasticity of the joint.

Ask your Jones representative for further information on the "Triple Threat".

THE S. M. JONES COMPANY
Division of Buffalo Eclipse Corporation
General Office and Factory: TOLEDO, OHIO
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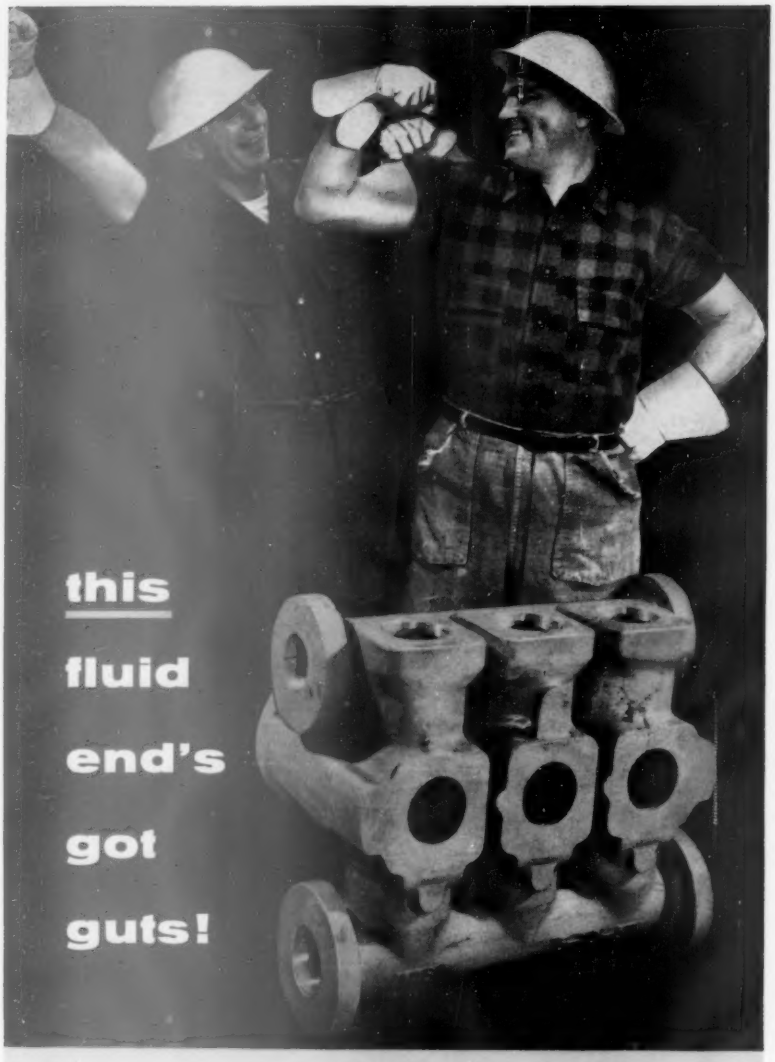
Export Department: The S. M. Jones Company

JONES SUCKER RODS
142



It's cast of AMPCO® metal
...even salt water can't damage it

Tough pumping conditions are duck soup to AMPCO metal. It's a two-fisted copper-base alloy that is specially engineered to guard against failure caused by corrosion, erosion, abrasion, and cavitation-pitting. It provides exceptional strength—yet it weighs 10-15% less than ordinary bronzes.

Check for this protection when you look at specifications of duplex and triplex-pumps. And—insist on fluid ends of AMPCO metal for replacements on your old pumps.

Send coupon today for further information on AMPCO metal in corrosive applications.

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Books

"History of Petroleum Engineering" by the Editorial Board of History of Petroleum Engineering and published by the American Petroleum Institute, Division of Production, 300 Corrigan Tower Bldg., Dallas, Texas. Contains 21 chapters, 1230 pages, 498 illustrations. Price: $10 (U.S.), $11 (outside U. S.).

The world's first comprehensive historical chronicle of the concepts, methods and equipment employed in drilling and production of petroleum. Ten years of research and organization by 23 nationally noted engineers, geologists and petroleum executives went into this work. While essentially a history of American petroleum engineering from the 1800's to the present, it also contains numerous and extensive references to foreign developments, including those of a century ago. Twenty-one chapters by outstanding authorities identify and document the role of petroleum engineering in the industry. D. V. Carter, division engineer manager, Mobil Oil Company, served as chairman of the Editorial Board of History of Petroleum Engineering for the API.

Mobil Travel Guides, published by Simon and Schuster, 630 Fifth Avenue, New York. Pages 336. Price $1 each.

Mobil Oil Company and Simon and Schuster, publishers, have prepared an American travel guide which describes local sights, and rates hotels, motels and restaurants impartially. From researchers' reports, a board of travel authorities selected 10,000 hotels, motels, restaurants and resorts for detailed coverage. There are four editions, each covering an area of the U. S.

Each of the four editions of the Mobil Travel Guide sells for one dollar and is available wherever books or pocket books are sold and at most Mobile service stations. Editions available and states covered in each are: (1) California and Nevada; (2) South Central and Southwestern States—Arizona, Arkansas, Col-

orado, Kansas, Louisiana, Missouri, New Mexico, Oklahoma and Texas; (3) Northeastern States—Connecticut, Massachusetts, Maine, Rhode Island, New Jersey, Vermont, New York and New Hampshire; (4) Great Lakes Area—Illinois, Indiana, Michigan, Ohio and Wisconsin.

"Third Edition—Compressed Air and Gas Handbook" developed, edited and printed by Editing and Publishing Board, Compressed Air and Gas Institute, 55 Public Square, Cleveland 13, Ohio. Contains eight chapters, 323 illustrations, 592 pages, 6 in. by 9 in., maroon cloth covered, gold stamped. Price: $8.

This is the all-new, expanded and completely revised Third Edition. Data are presented in curves or tables to facilitate their use. Whether the subject is large-capacity centrifugal compressors for use in the chemical industry or multiple pneumatic tools, automatic feeds and air gaging for modern manufacturing, the engineer will find an up-to-date discussion in the book. The text has been carefully indexed and cross referenced to assure usability.

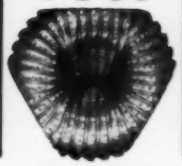
"Alaska Petroleum Directory — 1961 Edition" published by Petroleum Publications, Inc., Box 399, Anchorage, Alaska. Contains 5 sections, 108 pages. Price: $7.50.

If you are at all interested in Alaska, you need this fine directory. Section 1 is a listing of resident and non-resident oil and land companies active in Alaska. Section 2 lists personnel and offices of various federal and state government agencies concerned with oil in the state and includes a discussion of federal and state lease requirements and a USGS report entitled "Possible Oil and Gas Provinces in Alaska." Section 3 describes all wells drilled, or drilling as of March 1961, in Alaska since Nov. 1959. Section 4 lists service and supply companies, drilling contractors, and air carriers. Section 5 is the roster of the Petroleum Club of Anchorage. Published by Charles W. Barnes and John R. Roderick the attractive book contains advertisements which add to the worth of the directory. It is a very comprehensive guide to the oil industry in our 49th state.

FROM 2.2 FT./HR.

TO 6.0 FT./HR.

BY SWITCHING TO PC91



PERFORMANCE DATA

TYPE	FT. DRILLED	HOURS RUN	FT./HR.
MAKE A, ROCK BIT	3	2	1.5
MAKE B, ROCK BIT	11	5	2.2
HYCALOG, DIAMOND PC 91	**1440**	**240**	**6.0**

AT 12,000'-13,000' DEPTHS in South Louisiana where this run was made, the saving in trip time alone amounted to thousands of dollars. And the diamond bit cost no more than the dozens of conventional bits which would have been required to do the same job.

No isolated case, this is one of a long list of records. So why not let a Hycalog diamond bit set a profit-making record for you.

HYCALOG, INC.

505 AERO DRIVE, SHREVEPORT, LOUISIANA.

OFFICES IN PRINCIPAL OIL PRODUCING AREAS

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Exploration

ALASKA

Standard Oil Company of California, Western Operations, Inc., as operator for itself and Richfield Oil Corp. will drill an exploratory well in the Swan Lake area of the Kenai Peninsula about 13 miles east of the Swanson River field. The Swan Lake area has been approved as a unit by the U. S. Geological Survey. Surface location of the well is approximately 660 ft north and 1980 ft west from the southwest corner of Section 27, T8N, R7W, Seward Meridian.

APPALACHIAN AREA

The birthplace of the U. S. oil industry is the site of some of the most active oil search presently under way. Both major and independent companies are at work in western Pennsylvania, West Virginia, western Maryland, and southwestern Virginia. Extreme eastern Kentucky and eastern Tennessee are also under study. About 70 companies, led by Shell Oil Co. and Mobil Oil Co., are after leases in the area. Phillips Petroleum Co. has announced the start of a rather spectacular 16,000-ft test in West Virginia.

AUSTRALIA

After several weeks on production test, the first well drilled in Australia by Union Oil Co. of California, Cabawin No. 1, has been shut in. During the test, the well averaged approximately 60 bbl per day of 50-deg oil. Union's second test, Cabawin East No. 1, four miles east of the No. 1 well, is now drilling.

BOLIVIA

Exploration activities in Bolivia received a big boost with completion by Gulf Oil Corp. of two more producers. The Caranda field near Santa Cruz is the site of the two new wells, both flowing more than 1000 bbl per day from Tertiary rock, one at 3400 ft and the other at 3500 ft. One completion was about a mile northwest of the field discovery and the other about two miles northwest. The field now has four completions and is expected to be of major proportions.

BORNEO

A well drilled by Sarawak Shell Oilfields from a mobile drilling barge at Cochrane Shoals off the Sarawak (Borneo) coast has been called a dry hole after reaching a depth of 8000 ft. The hole was drilled by the barge Orient Explorer which is now working for the Shell Co. of North Borneo at Saracen Shoals, about 45 miles off the North Borneo coast.

CANADA

A significant natural gas discovery in northeastern British Columbia was announced by Hudson's Bay Oil and Gas Company Ltd., jointly owned by Continental Oil Co. and Hudson's Bay Co. The well, Hudson's Bay Cypress B-27-F-94-B-15, recorded natural gas flows as high as 11,600,000 cu ft per day on a drillstem test in the Baldonnel formation, and is located on a drilling reservation in the company's Sikanni Chief acreage block. A net pay thickness of 113 ft has been indicated in the discovery, which is 100 miles northwest of Fort St. John and 12 miles from the nearest production.

COLOMBIA

Tennessee Colombia, S. A., new member of the Tennessee Gas Transmission Co. organization, has begun drilling on a 125,000-acre concession in southern Colombia. A wildcat is drilling in the Upper Magdalena Valley near the city of Neiva, about 150 miles southwest of Bogota. The drilling program is being carried on in cooperation with International Petroleum (Colombia) Limited, an affiliate of Standard Oil of New Jersey. The first well will be a test of the Dina Anticline, with a projected maximum depth of 9500 ft. Drilling contractor is Loffland Bros. de Sud America.

HOLLAND

Exploration drilling in the North Sea off the coast of South Holland is expected to begin this month. The operating company will be N. V. Nederlandse Aardolie Maatschappij (N.A.M.), jointly owned by Bataafse Petroleum Maatschappij N. V. (a company of the Royal Dutch/Shell Group), and Standard Oil Co. of New Jersey. The mobile underwater drilling platform Triton will be moved to the drill site about 2½ miles off the Dutch coast, between The Hague and the Hook of Holland within Netherlands territorial waters. It is expected that the well will reach a depth of about 6500 ft.

ILLINOIS

A new McClosky Lime pay in Wayne County has been discovered by National Associated Petroleum Corp., Tulsa, who is attempting to confirm the new reserve by retesting an old marginal well in the area. The No. 2 Dr. L. H. Johnson, located 2 miles southeast of Sims, found oil saturation in the McClosky at 3501-12 ft. The well was fractured with acid, swabbed, then flowed 284 bbl the first 24 hr. After a second 24-hr test of 344 bbl, the well was choked down to 230 bbl per day.

LOUISIANA

A new oil producing zone, the Hosston, has been found in the Ruston field of Lincoln Parish. Harvey Broyles, Perry G. Holloway and others, No. 1 Mattie Sue Barham found oil stains in the Hosston at 7917-24 ft. After perforating, the well flowed 162 bbl of 38-deg oil through a ½-in. choke.

OHIO

A total of 50,000 acres of southeastern Ohio leases has been purchased in equal shares by Atlas Exploration Co., Tulsa, and Midwest

Oil Corp., Denver. Extending over parts of four counties, most of the acreage purchased is in Washington County near the Athens County line. Atlas has two rigs operating north of the new property and plans about 20 more tests during the rest of the year. One or two of the tests will probably be drilled on the newly acquired acreage.

PACIFIC NORTHWEST

Shell Oil Co. has applied to the Department of the Interior for authorization to conduct geological and geophysical explorations on the Outer Continental Shelf off Oregon and Washington. The Regional Oil and Gas Supervisor of the Geological Survey, Los Angeles, who will grant the permit, said that although no commercial oil and gas deposits have been discovered in the Pacific Ocean off Oregon and Washington, there are reasons for believing that accumulations of oil and gas may exist.

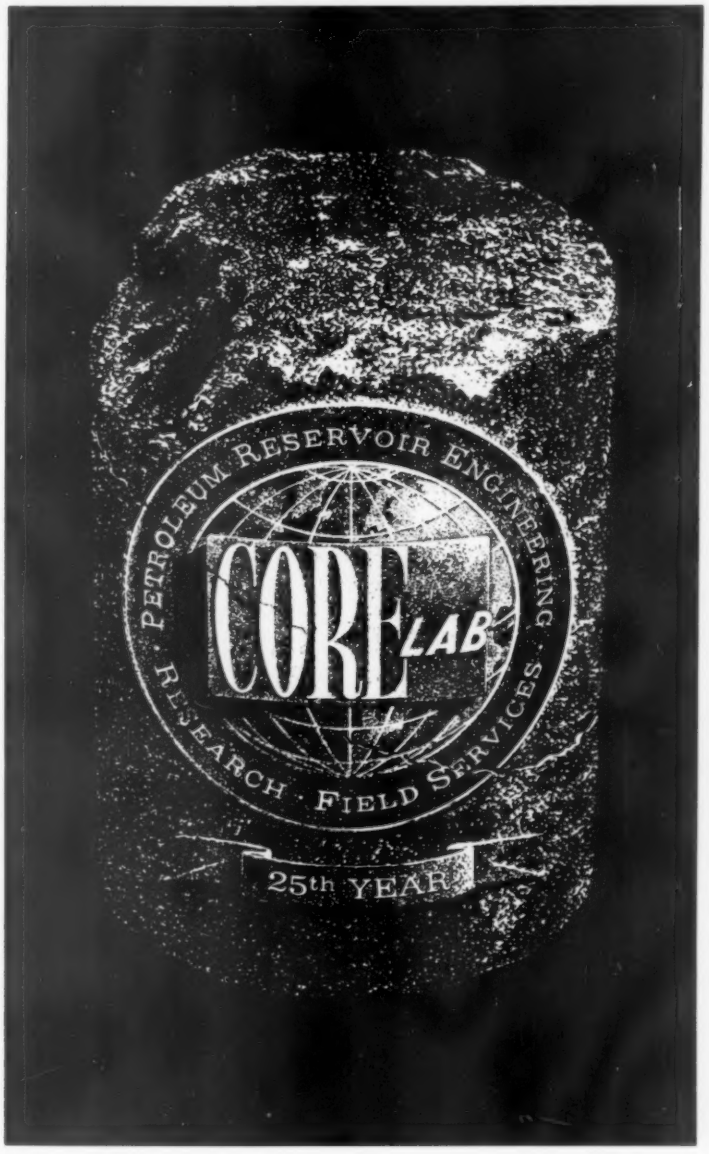
PAKISTAN

Soviet equipment and technicians are part of an exploration contract signed by Pakistan and the USSR. Exploration in West Pakistan is to begin on Potwar Plateau where the country's only producing oil wells are located. East Pakistan exploration will be near the Sylhet gas fields. No limit was imposed on the number of technicians who will participate in the contract and train Pakistani personnel.

TEXAS

The No. 5 E. D. Harris has been completed as a Yates gas discovery in the Harris (Queen) field of Gaines County by Texaco Inc. Producing from 3010-90 ft, the well had a calculated absolute open flow test of 263,000 cu ft of gas daily after being acidized and fractured. Total depth is 4300 ft and the well is located 10 miles south of Seminole.

Four tracts totaling 5760 acres in the Gulf of Mexico brought a high bid with a $1,258,993 bonus from Gulf Oil Corp. in a sale of Texas State oil and gas leases. The acreage is about 4 miles off Padre Island in an unproved area. All tracts call for $5 per acre annual rental and 1/6 royalty. Socony-Mobil Oil Co. drew one tract. The School Land Board received almost $5 million for the total of 88,531 acres.



Pacemaker for twenty-five years of petroleum reservoir engineering services . . . And as we pass the quarter-century mark, more people in more places are using more Core Lab data than ever before.

UNITED STATES CANADA SOUTH AMERICA EUROPE AFRICA

What's doing in Drilling

Offshore Moves Rig to Africa

The first important program of offshore drilling ever undertaken in African waters has been started by The Offshore Company off the coast of Gabon Republic. The company's Rig 59 and its tender No. 3 have been towed from Rotterdam, Holland, to work for Offshore International, S. A., under contract with Mobil International Oil Co. and a French firm, SPAEF.

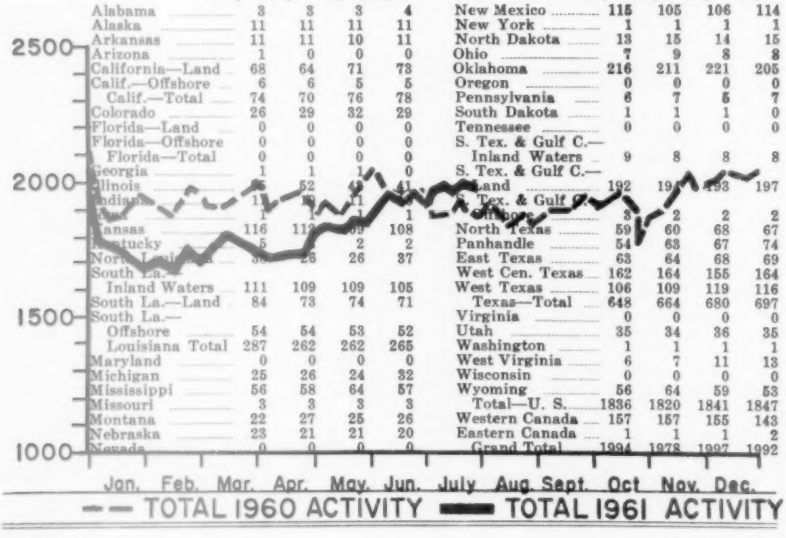
The tri-legged, self-elevating rig will be serviced from a base camp set up near Cape Lopez, the western-most part of Gabon, an independent republic with the French community of nations and territories. The platform is equipped with 200-ft legs which enable it to operate in waters well over 100 ft deep.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oil Well Drilling Contractors by Hughes Tool Company.

	July 10	July 17	July 24	July 31
Alabama	3	3	3	4
Alaska	11	11	11	11
Arkansas	11	11	10	11
Arizona	1	0	0	0
California—Land	68	64	71	73
Calif.—Offshore	6	6	5	5
Calif.—Total	74	70	76	78
Colorado	26	29	32	29
Florida—Land	0	0	0	0
Florida—Offshore	0	0	0	0
Florida—Total	0	0	0	0
Georgia	1	1	1	0
Illinois	55	52	41	41
Indiana	11	10	11	11
Kansas	116	112	99	108
Kentucky	5		2	2
North Louisiana		26	26	37
South La.—				
Inland Waters	111	109	109	105
South La.—Land	84	73	74	71
South La.—				
Offshore	54	54	53	52
Louisiana Total	287	262	262	265
Maryland	0	0	0	0
Michigan	25	26	24	32
Mississippi	56	58	64	57
Missouri	3	3	3	3
Montana	22	27	25	26
Nebraska	23	21	21	20
Nevada	0	0	0	0

	July 10	July 17	July 24	July 31
New Mexico	115	105	106	114
New York	1	1	1	1
North Dakota	13	15	14	15
Ohio	7	9	8	8
Oklahoma	216	211	221	205
Oregon	0	0	0	0
Pennsylvania	6	7	5	7
South Dakota	1	1	1	0
Tennessee	0	0	0	0
S. Tex. & Gulf C.—				
Inland Waters	9	8	8	8
S. Tex. & Gulf C.—				
Land	192	194	193	197
S. Tex. & Gulf C.				
Offshore	3	2	2	2
North Texas	59	60	68	67
Panhandle	54	63	67	74
East Texas	63	64	68	69
West Cen. Texas	162	164	155	164
West Texas	106	109	119	116
Texas—Total	648	664	680	697
Virginia	0	0	0	0
Utah	35	34	36	35
Washington	1	1	1	1
West Virginia	6	7	11	13
Wisconsin	0	0	0	0
Wyoming	56	64	59	53
Total—U. S.	1836	1820	1841	1847
Western Canada	157	157	155	143
Eastern Canada	1	1	1	2
Grand Total	1994	1978	1997	1992



Global Marine Sells 45% to Aerojet

Global Marine Exploration Co., a subsidiary of Union Oil Co. of California, has sold 400,000 shares of treasury stock to Aerojet-General Corp. This represents 45% of the company stock; the remainder is owned 45% by Global and 10% by Global personnel.

Global Marine's operations will be divided into two units, one of which will be substantially in support of oil exploration which it has carried on in the past; the other will be devoted to general efforts in oceanic exploration.

An Aerojet-General spokesman commented, "We feel that the pioneering work done by Global Marine in certain areas of oceanic exploration will greatly increase our dual potential to discover and use the resources of the world's oceans for commercial purposes of great benefit to mankind."

AAODC Sets Annual Meeting

The 21st annual meeting of the American Association of Oilwell Drilling Contractors will be held this year at the Rice Hotel in Houston, Texas. Meeting dates are October 4-6, 1961.

Room reservations for the meeting can be made through the Housing Committee, AAODC, P. O. Box 38, Houston, Texas.

Contractor Gets API Award

H. J. "Red" Magner, vice president and manager of eastern operations for Delta Drilling Company, Pittsburgh, was cited for outstanding service to the petroleum industry with an award of "Citation for Service" from the American Petroleum Institute. Gage Lund, API

vice president for production and vice president of the Standard Oil Company of California, presented the award at the recent Eastern District API meeting held at White Sulphur Springs, West Virginia.

Soviets Design 32,000-ft Hole

The USSR Drilling Technique Research Institute has announced the design of a well intended to go down 10 kilometers (32,810 ft) into the earth. Without giving details about where and when such a hole is to be drilled, the Institute claimed to have the solution to several problems involved.

One such solution is replacement of conventional steel drill pipe by light alloy pipe three times lighter than steel pipe and more highly heat-resistant. Special chemical reagents have been created to increase heat resistance and lower viscosity of clay muds for use at the high temperatures expected.

Institute scientists also claim development of a special heavy cement which will withstand the elevated temperatures.

Drilling of the giant well is to be done with a diamond bit of Soviet manufacture, already created and undergoing tests. At the outset it is intended to do the drilling with conventional rotary. Later, the Soviets will use the turbodrill and electrodrill for further drilling.

Texas A&M Sets Drilling Courses

The petroleum engineering department of Texas A&M College and the American Association of Oilwell Drilling Contractors are sponsoring two identical courses in advanced drilling engineering at A&M. Dates have been set at October 16-27, 1961, and February 19-March 2, 1962. Registration fee is $250 per person through Robert L. Whiting, Petroleum Engineering Dept., A&M College of Texas, College Station, Texas.

Outline of the two-week course includes: Introduction; Rocks; Circulating Fluids; Drill Strings; Rotary Drilling Bits; Crooked Hole Problems; Controlled Directional Drilling; Factors Affecting Rate of Penetration; Factors Affecting Hole Oversize, Sloughing, Uniformity of Wall and Differential Sticking of Drill Pipe; Design and Selection of Various Component Parts of the Drill String; Optimum Conditions for Rock Penetration; Operations Associated with Drilling; Drilling Economics; and Methods of Reducing Drilling Costs.

Big Rig in West Virginia

Phillips Petroleum Company has begun drilling what may be the deepest well ever drilled in the Appalachian region on a location near Fairmont, West Virginia, just 20 miles south of the Pennsylvania state line. It will be company tools all the way.

For this deep test, Phillips barged its big rig up the Mississippi into the Ohio River and on to Charleston, West Virginia, where the equipment was unloaded and then trucked to location. The company is equipped to handle both air and mud drilling in this area where air/gas drilling has performed so well.

Crews Battle Canadian Fires

Spring and summer forest fires have interrupted drilling operations on several rigs operating in Canada. Twenty men of a Mobil Oil of Canada contract drilling crew, trapped by a raging forest fire they were helping to fight, saved themselves by splashing in a small creek as the fire swept over them.

At their camp, five buildings, some wiring, and the derrick run-around

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were destroyed. Scene of the fire was Mobil's Nosehill Creek 6-32, a wildcat 150 miles west of Edmonton.

Operations at Mobil's Jackfish 10-17, wildcat about 15 miles north, were also suspended when rig crews were commandeered by government forest rangers and the Royal Canadian Mounted Police to help fight a fire.

Earlier, Mobil's operations in the Pembina oil field were disrupted by a fire that covered 20 acres before being brought under control.

New Director for Zapata

Robert H. Gow, president of Champlain-Zapata Plastic Machinery Inc., was elected a director of Zapata Off-Shore Company of Houston. Champlain-Zapata was recently formed by Champlain Company, Inc. of Roseland, New Jersey and Zapata to design and make machines used in the expandable polystyrene field. Zapata also has interests in National Tube Coating, Inc. of Beaumont, Texas, which plastic coats oilfield tubing.

Mobil Gas-Drills in So. Louisiana

In the Iowa field of Calcasieu Parish, Louisiana, Mobil Oil Company drilled a 255-ft section with gas for an average penetration rate of 117 ft per hour. This was nearly 50 times as fast as the conventional 2.6 ft per hour mud-drilling rate in this area. The gas-drilled section was below 9300 ft deep. Mobil hopes the technique will cut costs up to $20,000 per well.

Alaska Rig Count Hits High of Eleven

For the first time in Alaska oil history, there were eleven drilling rigs running, according to a July report. Seven of the eleven were working for Standard Oil of California; Union, Richfield and Colorado each were working a rig. Three of the wells were drilling below 11,000 ft.

Contractor Gets Aluminum Drill Pipe

The first string of aluminum drill pipe to be tested by a drilling contractor goes to Prime Drilling Co. of Wichita, Kansas. The 5200-ft aluminum string made by Reynolds with special tool joints made by Reed Roller Bit Co. will be used on a 7000-ft rotary rig. Shell Oil Company has been testing an aluminum

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string for the past six months during which time it has drilled more than 75,000 ft of hole without failure or complications.

Gas Search Boosts Rig Activity

A look at rig activity levels in the U. S. and Canada shows an ecouraging continued increase in busy rigs. Last June, the active rig count climbed ahead of the year-earlier rate for the first time since November 1959. The count has increased steadily from a 15-year low of 1479 rotary rigs busy in the week of February 13, 1961.

Much of the favorable trend in rig activity is due to the search for gas production in the face of a continuing glut of crude-producing capacity. For example, Texas producers completed a record of 68 gas discovery wells in the week of August 7, bringing the year's total up to 435, compared with a total of 57 new gas wells at the same time last year.

Texas University Conducts Bit Research

The University of Texas' petroleum engineering department has been given by the Jersey Production Research Co. a specially designed rock-chipping machine built to study rock failure under controlled loading conditions.

Costing approximately $20,000, the machine consists of a mechanically actuated, wedge-shaped chisel designed to strike either single or multiple blows on rock samples. The machine measures both force of the blow and chisel velocity during the operating cycle.

The research company said the results of continuing rock-failure studies at the University may ultimately lead to improved design of drilling bits to increase efficiency of operation. JPRC also made a monetary contribution to support the rock mechanics research program.

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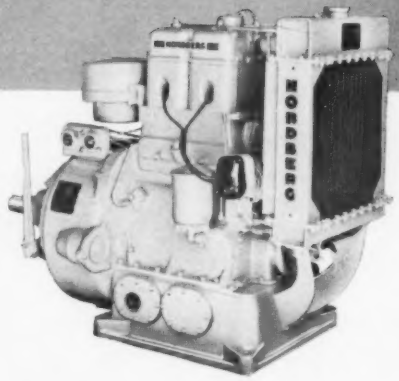

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Nordberg sales and service facilities for Power Chief Diesel and Gas Engines have now been expanded by the recent appointment of *Sondo Sales Company*, Tulsa, Oklahoma, as distributors for these heavy duty, medium speed units throughout the oil fields. Maintaining offices and warehouses in Tulsa, Pampa, Texas and Great Bend, Kansas, Sondo has 16 field men on the job to make sure your power problems are solved promptly and efficiently.

Since the only business of Sondo Sales is concentrated on the sales and service of Power Chief Engines, you can be sure of specialized attention. Call them today or write for bulletins on Power Chief Diesel Engines and Power Chief Gas Engines. These heavy duty oil field engines are available in 1, 2 and 3 cylinder sizes with power to 54 hp or 30 kw.

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Forty-Ninth State Commemorates Its First Oil Well

In commemoration of the first commercially-successful oil well in Alaska, a specially designed memorial has been presented to the state by Richfield Oil Corporation.

Accepted for Alaska by Gov. William Egan, the memorial is prominently located in the State Capitol and will be displayed at the International Airport in Anchorage during the Western Governor's Conference in 1962.

Terming the discovery of oil in the state "a milestone in Alaska's history in which Richfield has played a leading role," the Governor declared that, "the revenue which has accrued to our State government and to the economy generally, has in large measure assured the financial stability of the forty-ninth State."

Richfield president Charles S. Jones made the presentation on behalf of the company.

Richfield's historic discovery was made four years ago, in July 1957, in the Swanson River field on the Kenai Peninsula. Since the discovery, Standard Oil Company of California has become the operator and a partner with Richfield in developing the Swanson River field and the Soldotna Creek field where oil was discovered early in 1960. Today, there are 38 producing wells in the two fields producing approximately 20,000 bbl per day and exploration is being carried on in other areas of the state.

Focal point of the design is a large glass drop suspended in a silver wire outline of the world with the tip of the drop protruding at the point where the Kenai Peninsula is located. It is partially filled with crude from the first well. The globe is mounted on a wooden base containing a relief outline of Alaska and the state flag stands atop the globe.

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Drill fewer injection wells... Eliminate multiple strings

Camco invites you to save thousands of dollars in secondary recovery costs by drilling fewer injection wells and eliminating extra tubing required for concentric and multiple strings. Deplete multiple zones by selective waterflood injection **from a single tubing string** with

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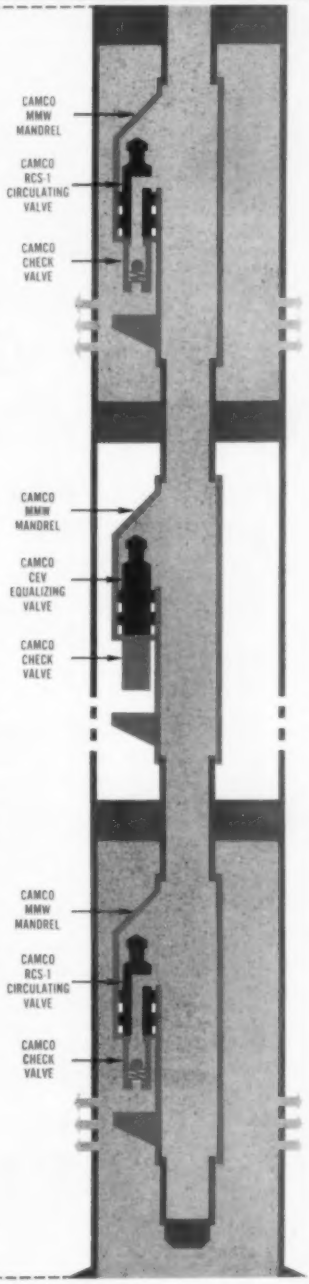

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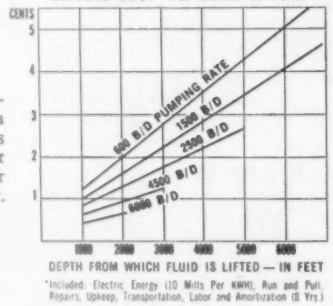

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Reda Submergible Pumps are designed to meet every pumping need — for wells with small fluid volumes, large fluid volumes, new wells or secondary recovery operations. Daily production rates from 20 barrels of oil to 18,000 barrels of salt water producing less than 1% of oil. Depths of wells are from 450 feet to 13,000 feet. Complete line from ⅓ H.P. to over 300 H.P.

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Running Tour

Recent appointments in the supply and transportation department of Humble Oil & Refining Co., Houston, include John G. Yeager, manager of crude oil; J. E. McCleary, head of crude oil contracts and negotiations; A. J. Ferguson, coordinator of planning, evaluations and forecasts; G. W. LeVan, head of the department's division order group, and Joe C. Delaney, head of the crude oil evaluation section in the headquarters supply and transportation department.

W. L. Broussard, Victoria, Tex., district drilling supervisor for Mobil Oil Co., is on three-months' loan to Mobil Oil Francaise to advise on the marine aspects of rigging up and drilling a wildcat off the coast of Gabon.

L. Lynn Elliott's appointment as vice president and general counsel of Tower Oil & Gas Company of Texas, Dallas, is another in a series of changes being made to consolidate and streamline all of Tower's operations. Elliott formerly was administrative assistant and associate counsel.

A. Hargrave

Lone Star Gas Co. has named Austen Hargrave as manager, gas supply department, exploration and gas supply division, succeeding the late Elster A. Smith. Hargrave has been assistant manager since 1956.

Robert E. McCarley has joined M. J. Delaney Co., Dallas, as production and drilling engineer. Previously he was senior drilling engineer for the Mid-Continent region of The Atlantic Refining Co., Dallas.

Loffland Brothers Co. has promoted Glenn F. Miller from assistant superintendent of the southern division to southwest division superintendent with headquarters in Odessa, Tex. Rowden H. Tipton has been made Northern Louisiana district manager.

Six key personnel changes in Gulf Oil Corp.'s domestic production staff: W. H. LeGrand, in charge of offshore and onshore production activities, the Delta area, Louisiana; H. F. Swannack, production manager of the Pierce Junction area; F. B. Inks, Odessa, Tex., area drilling foreman; J. L. Herndon, New Orleans, La., district landman; T. A. Trax, Wichita Falls, Tex., area production manager, and T. W. Kidd, Odessa area production manager.

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J. G. Dodd

James G. Dodd, formerly an independent consultant in Houston, Tex., is now in charge of the Houston office of Oliver & West, Inc., petroleum consultants. He formerly was associated with Humble Oil & Refining Co. in subsurface geology and worked in the gas reserve department of Tennessee Gas Transmission Co.

New executive vice president of Texas Pacific Coal and Oil Co. is Robert W. Hines, who joined the firm in 1954 as assistant manager of production. He became production manager and a member of the board in 1957 and vice president of production in 1959.

Two Midland, Tex., executives of Husky Oil Co. are being transferred to Denver with establishment of headquarters of the land and geological department in the Colorado city. Involved in the shift are W. C. (Bill) Kimball, manager of the land department, and Norris N. Requist, chief geologist.

In the producing department of Mobil Oil of Canada, Calgary, Alta., Richard S. Hebberd has been appointed joint interest manager and James A. Kelly has been named to succeed Hebberd as Pembina district producing superintendent. Kelly was production and drilling section chief.

Ralph H. Viney has resigned his position as vice president and petroleum engineer of the First National Bank, Ft. Worth, Tex., to become a private consultant to the oil and gas industry. Temporarily his office is at his home, 6820 Middle Road, Ft. Worth.

Humble Oil & Refining Co. has consolidated two operating groups, the Monterey division and the California area, into the new Los Angeles area operating territory.

R. E. Faggioli, formerly California area manager, has been appointed Los Angeles area manager. While he completes a temporary assignment as executive assistant to the president in Humble's Houston, Tex., headquarters, N. N. Jones will serve as acting manager of the new area and later will become produc-

tion manager. A. W. Gentry, who has been serving as president of the Monterey division, will be acting production manager during this interim period.

Additional appointments to the area include J. R. Jackson, exploration manager; J. L. Spivey, marketing manager; E. E. Pyles, assistant to the area manager; B. L. Smith, employee relations manager; W. R. Gardner, attorney, and T. M. Roper, administrative service manager.

Three men honored with awards for outstanding service to the petroleum industry and the American Petroleum Institute are James M. Bird, Birdwell Div., Seismograph Service Corp.; N. C. Ludwig, Universal Atlas Cement Co., and H. J. Magner, Delta Drilling Co.

The Independent Petroleum Association of America has made three staff changes in its public information department. Alan L. White has been promoted from editor of the association's magazine, the Independent Petroleum Monthly, to assistant director of information in Washington, D. C. Young O. Mitchell moves up to editor from associate editor. Joseph W. Farmer, who has been in charge of IPAA's membership promotion activities, becomes associate editor.

E. M. (Eddie) Gorence has been promoted to manager of the land department of Phillips Petroleum Co.'s western exploration division in Midland, Tex. He has been assistant manager since 1960.

Retirements announced by Sun Oil Co. include Philip S. Justice as special assistant to John G. Pew, senior vice president in charge of production, and Herman G. Biederman as division office manager of the firm's Mid-Continent production division.

In the domestic producing department of Texaco, Inc., Otis B. Hocker has been promoted to assistant to the vice president and Roy Whisenhunt to Denver, Colo., division manager.

Other promotions include J. E. Ellis, division petroleum engineer, Tulsa, Okla.; C. F. Fain, assistant division petroleum engineer, Houston, Tex.; V. F. Dullnig, staff petroleum engineer in the general manager's office, Houston, and J. M.

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Williams, Jr., assistant petroleum engineer, Midland, Tex., division.

Other departmental appointments are: Kenneth E. Myron, Los Angeles, Calif., division manager; Bryon L. Francis, assistant division manager, Midland, and Laurie W. Folmar, staff petroleum engineer, New York, N. Y.

Dean A. Chase has been promoted to general production superintendent for all operations of Lario Oil & Gas Co. He has been superintendent of the firm's Midland, Tex., division, where he will continue to headquarter.

R. F. Cox

A. E. Beasley

Southwest Gas Producing Co., Inc., Monroe, La., has elected R. F. Cox vice president in charge of production and Al E. Beasley vice president in charge of exploration. Cox previously was general production superintendent, while Beasley has been general exploration manager.

John L. Wylie is new personnel manager of the Murphy Corp. He formerly was public relations director at the El Dorado, Ark., refinery of American Oil Co.

AAPL's first annual special awards have been presented to the Denver Association of Petroleum Landmen, the Panhandle Association of Petroleum Landmen of Amarillo, and to: W. M. Majors, Jr., Cal-Ray Petroleum Corp.; William T. Blackburn, Vaughey, Vaughey & Blackburn; Leslie J. Moses, Crown Central Petroleum Corp.; J. Phil McGowan, Continental Oil Co.; and M. S. Pettersen, The Ohio Oil Co.

Winners of AAPL's depletion contest are: Frank N. McMillan, Southern Minerals Corp.; Durland Clark, Shell Oil Co.; and Art Hart, Sun Oil Co.

George L. Roller has joined Van Dyke & Mejlaender as a specialist in geology of southeast Louisiana. He was most recently an exploration and operations geologist in the New Orleans, La., office of Pan American Petroleum Corp.

Dr. Henry J. Schaetti, section head in Jersey Production Research Co.'s geological research division, has been named chief geologist of Esso (Sahara) Inc., a Standard Oil Co. (N.J.) exploration company operating in Algeria.

Herschel C. Martin, controller, officer and director of companies in the Dallas, Texas, office of Wrather Interests, has been elected president of the Petroleum Accountants Society of Dallas for the 1961-62 term.

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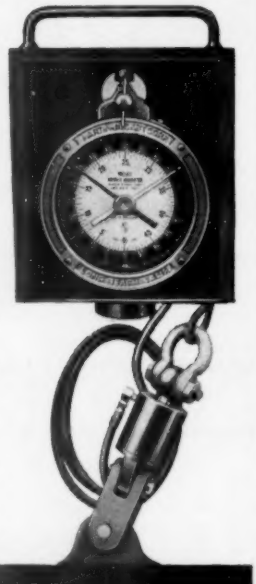

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Two pointers are provided, one reads the total hook load in pounds for two or four lines strung, and the other is a target pointer.

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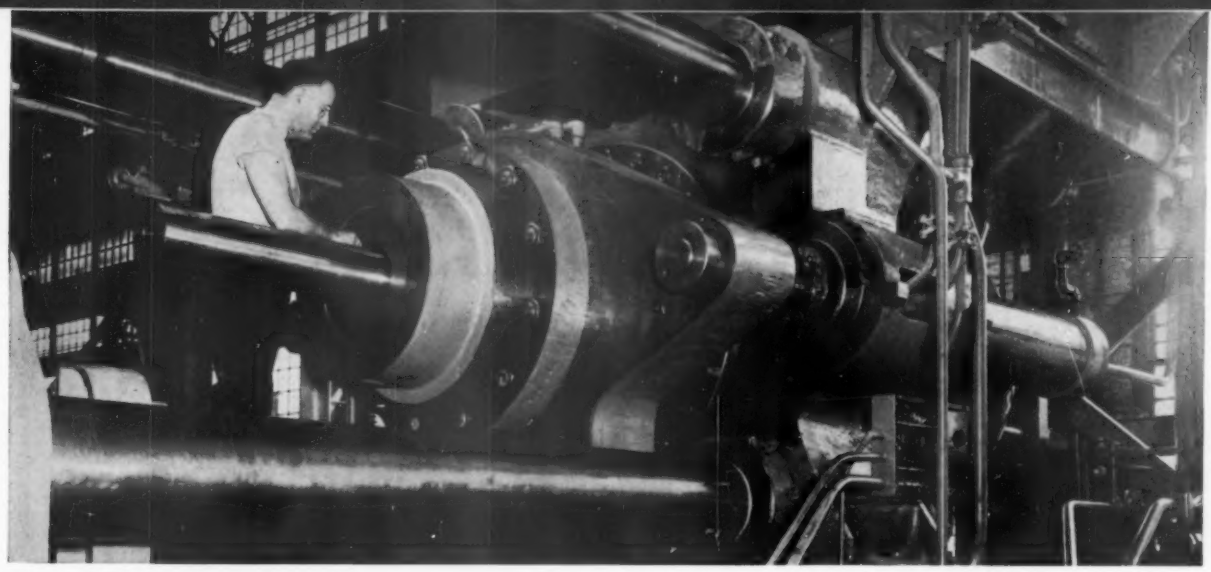
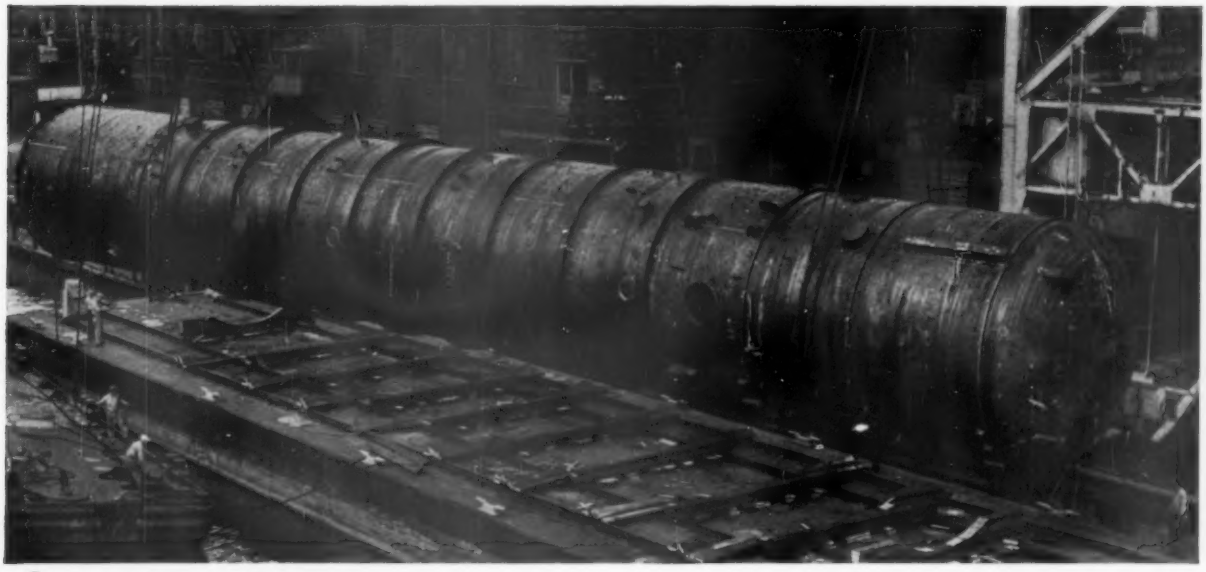


SUN SHIP has what it takes to build . . . . .



for INDUSTRY

We're old hands at building complete machines and special equipment for use in a wide range of industries. For 44 years our large and amply equipped shops have produced items ranging from small tanks to huge fractionating towers, pressure vessels, stills, plate work and special-purpose machinery for the chemical, petroleum and other industries.

Pictured here are a hydraulic press, which was shipped by rail, and a fractionating tower ready for loading on a barge for shipment by water to an oil refinery. They are just two examples of the equipment Sun Ship contributes to many fields, also examples of our shipping facilities.

Because we have all the facilities, we build all equipment right in our own plant, without subletting. Our convenient location on the Delaware River, with direct access by rail and water to all points, assures speedy delivery.

Let Sun Ship solve your machine or equipment problem. Phone or write our Sales Engineering Department.

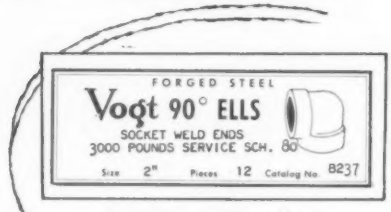
Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • SINCE 1916 • CHESTER, PA.

Vogt PACKAGED

FORGED STEEL FITTINGS, FLANGES and UNIONS



Complete product identification and data on label attached to carton.

Vogt modular designed cartons give added handling and storage space economies. All dimensions are in multiples of 3 inches.

for MATERIAL HANDLING ECONOMY

1 Easy Inventory Identification

2 Easy Handling

3 Protection Against Damage

Handling and inventory costs are held to a minimum with Vogt modular packaged forged steel fittings, flanges, and unions. The small cartons, of restricted weight, are appreciated by the distributor and user alike for their easy handling and the protection given the products against damage.

The label attached to each carton completely describes and pictures the product and gives the quantity, size, end type, pressure, and catalog number.

Write for Folder PF-1 for complete data on quantities and weights of the items as packaged in various sizes of cartons.

Address Dept. 24A-FPC

HENRY VOGT MACHINE CO.

P.O. Box 1918 Louisville 1, Ky.

SALES OFFICES New York, Chicago, Cleveland, Dallas, Camden, N.J., St. Louis, Charleston, W. Va., Los Angeles

Construction Briefs

Gulf Oil's first petrochemical plant outside the company's refineries, an ethylene unit capable of producing over 400,000,000 lb per year, will be built near Mont Belview, Texas, approximately 30 miles east of Houston.

Plant is first unit in a proposed petrochemical complex to be constructed on the 1000-acre site. Additional facilities include a high purity propylene plant to be erected at an early date.

Brown and Root has construction contract for a 45,000,000-lb-per-year vinyl acetate monomer plant to be built at a Gulf Coast site by National Starch and Chemical. Cost will be approximately $4,000,000.

Other key contracts awarded to:

Canadian Bechtel, Ltd., Toronto, for Shell Oil of Canada's $20,000,000 gas processing and sulfur manufacturing plant at Pincher Creek, Alta.

Lummus Co., for a 28,000-ton-per-year polybutadiene rubber plant at Recife, Brazil, to be built for an agency of the Brazilian government and operated by Firestone Tire & Rubber Co.

Procon Inc., for APCO Oil Corp.'s 2950-bpd Lomax unit at the Arkansas City, Kans., refinery.

Hudson Engineering Corp., for Humble's Sand Hills gas treating and processing plant in Crane County, Texas, to process 40,000 Mcf per day.

Service Engineering Co., Oklahoma City, for Kerr-McGee's helium extraction plant in the Pinta Dome field at Navajo, Ariz. Only privately owned helium plant in the U. S., it will produce 200,000 std cu ft of helium per day.

Blaw-Knox, Pittsburgh, for Ancon Chemical's plant at Lake Charles, La., to produce about 60,000,000 lb of methyl chloride annually. Ancon is jointly owned subsidiary of Ansul Chemical Co. and Continental Oil Co.

Lummus Co., for engineering a saline water conversion plant at Wrightsville Beach, N. C., to produce 250,000 gal of fresh water per day.

Austin Rankin Corp., Houston, for Cities Service's natural gasoline plant in Calhoun County, Texas, to process 10 MMcf of gas daily from the North San Antonio Bay field.

Lurgi Gesselschaft Fur Mineraloltechnic, MBH, Frankfurt, Germany, for $10,000,000 paraxylene plant at Dinslaken, West Germany, for Deutsch BP und California, partnership of German subsidiaries of Standard Oil of California and British Petroleum, Ltd. Annual capacity will be 14,000 metric tons.

Foster Wheeler Corp., for engineering of refinery for Australian Lubricating Oil Refinery, Ltd., Kurnell, Australia, to produce 140,000 tons of lubricants per year. ALOR is owned by California Texas Oil Co., Sleigh Pty., Ltd., and Ampol.

Catalytic Construction of Canada, Ltd., Sarnia, Ont., for engineering-procurement-construction of a 20,000-ton-per-year polybutadiene plant at Sarnia for Polymer Corp., Ltd.

M. W. Kellogg Co., for a $2,500,000 addition to Barrancabermeja, Colombia, oil refinery.

Scientific Design Co., for design and construction of Rohm & Haas' multi-million dollar adipic acid plant at Louisville, Ky.

Kellogg-Panamerican Corp., for an oil refinery in Tucuman province, Argentina, for Refineries Argentinas de Petroleo.

Other new plants announced:

NV Petrochemie AKU-Amoco's terephthalic acid plant in extreme northern Netherlands, near Delfzijl. Company is jointly owned by Amoco International SA and Algemene Kunstzijde Unie NV.

Petrobras' 29,000-metric-ton-per-year dehydrogenation unit at Duque de Caxias, near Rio de Janeiro, Brazil, licensed by Houdry-Brazilian Co. Plant will produce butadiene from normal butane or mixtures of butane and butenes.

Hunt International Petroleum's 15,000-bpd refinery at Monrovia, Liberia.

Allied Chemical's plant in Southern California to produce 15,000,000 lb annually of isocyanates.

Atlas Chemical Industries' 50,000,000 lb-per-year glycerin and related higher alcohols plant near Wilmington, Del.

Steelman Gas, Ltd.'s $1,600,000 unit for extracting ethane, propane and butane from natural gas pipelines converging near Edmonton, Alta.

Humble's additions to polyolefin manufacturing facilities at Baytown, Tex., which will expand capacity to 80,000,000 lb a year by second half of 1962.

Phillips Petroleum's alkylation unit at its Woods Cross, Utah, refinery.

National Petro Chemicals Corp. high density polyethylene plastic plant at Houston, costing $15,000,000 to $20,000,000, and jointly owned by National Distillers & Chemical Corp. and Owens-Illinois Glass Co.

Sherrit Gordon Mines, Ltd., urea plant at Ft. Saskatchewan, Alta., with capacity of 35,000 tons per year.

A $24,000,000 ammonia and urea plant on Formosa to be built by Mobil Chemical Co., Allied Chemical Corp. and Chinese Petroleum Corp.

SAMPLE NO. 46081

TABLE I

EVALUATION OF LEAD ALKYLS

	RESEARCH OCTANE NUMBER					
	97.0	98.0	99.0	100.0	101.0	101.3
	COST, CENTS PER GALLON					
TEL	0.1098	0.2275	0.3763	0.5482	0.7621	0.8519
25/75 TML/TEL	0.1567	0.2421	0.3642	0.5395		
MLA 250	0.1261	0.2092	0.3313	0.5149		
50/50 TML/TEL	0.1632	0.2532	0.3794	0.5550		
MLA 500	0.1424	0.2274	0.3475	0.5182	0.7552	
75/25 TML/TEL	0.1998	0.2819	0.3978	0.5699		
MLA 750	0.2019	0.2718	0.3682	0.5115	0.7537	
TML	0.2769	0.3517	0.4575	0.6293		

	CORRESPONDING MOTOR OCTANE NUMBER					
TEL	87.0	88.5	89.9	91.2	92.2	92.5
25/75 TML/TEL	87.5	88.5	89.8	90.8		
MLA 250						

WHICH ANTIKNOCK GIVES YOU BEST COST EFFECTIVENESS?

Ethyl's "MLA" and "TELMEL" antiknocks are proving to be highly effective and economical in many gasolines. This finding is based on an extensive evaluation program to aid refiners in selecting the best antiknock for their gasolines.

As an example, one refiner marketing a typical premium gasoline found he could save 1.9¢ per barrel, at the same Research octane number, by using "MLA" 250 instead of TEL.

In the program to date, over 300 gasoline samples, representing 80% of total refining capacity, have been knock-rated in the laboratory using eight "Ethyl" antiknocks in varying concentrations.

This program included approximately 16,000 ratings by Motor and Research methods alone. In addition, 500 bled manifold ratings have been made in an effort to predict the road performance of the various lead alkyls in cars with manual transmissions. Reid Vapor Pressure, distillation, hydrocarbon-type analysis, sulfur content and API gravity make up several hundred more individual determinations of quality that were run on these fuel samples.

The octane ratings from each sample were programmed through a computer to compare the cost effectiveness of each antiknock at several lead concentrations covering a range of octane numbers. In addition, the results show the octane numbers obtainable for a range of antiknock costs. In many cases, the mixed lead alkyls or "TELMEL" mixtures look more promising than either TEL or TML alone.

Based on laboratory findings, various combinations of gasolines and the new antiknocks have been selected for road rating studies. As a result, Ethyl's chassis dynamometers are running night and day to get the road ratings that complete the antiknock selection picture.

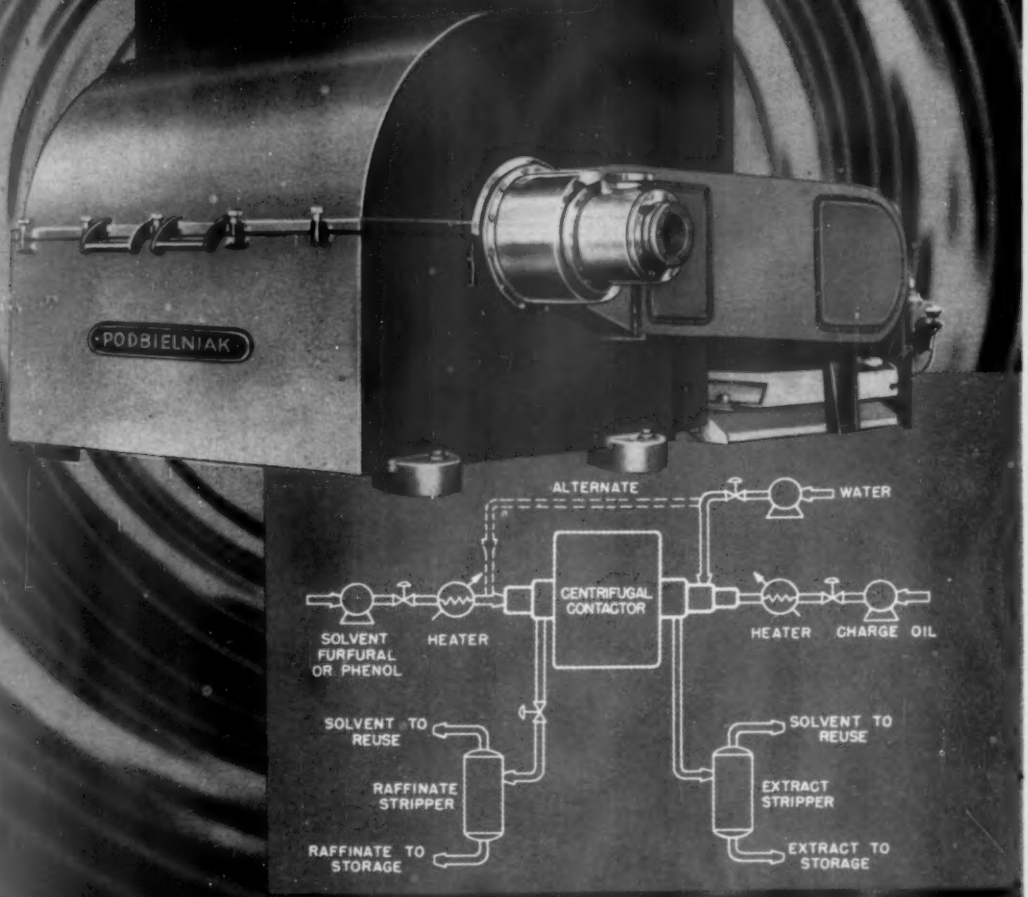
If you are a refiner facing the "which antiknock" question, and want help in the optimum selection, call your Ethyl Representative.

Ethyl Corporation

NEW YORK • TULSA • CHICAGO • HOUSTON • LOS ANGELES

ETHYL CORPORATION OF CANADA LIMITED, TORONTO • **ETHYL USA (EXPORT)** NEW YORK 17, N. Y.

"TOWERLESS" REFINING YIELDS BIGGER PROFITS



TECHNICAL CATALOG:

Write for copy of illustrated catalog which tells the interesting story of the Podbielniak centrifugal contactors.

Dresser-Podbielniak Centrifugal Contactor Permits Lower Costs, Increased Efficiency

A COMPACT PODBIELNIAK CENTRIFUGAL CONTACTOR can replace a conventional gravity tower a hundred feet high and eight feet in diameter, with comparable capacity, greater efficiency, more versatility and increased ease of operation. Using up to 2000 times the force of gravity, Podbielniak contactors effect controlled mixing and phase separation as required in countercurrent multistage solvent extraction processes.

COMPACTNESS OF THE UNIT results in a 95 per cent reduction of solvent inventory and material in process. Almost instantaneous response to control allows rapid switching of feed stocks to permit "on-spec" production soon after changeover.

INSTALLATION OF A PODBIELNIAK equipped furfural extraction plant costs only one-third of additional cracking facilities required to obtain the same increase in virgin charge capacity. A wide range of Podbielniak extractors is available, with rotors up to 48 inches in diameter by 60 inches wide, handling 600 gallons per minute combined flows for gas oil-solvent application.

THE ADDITION OF PODBIELNIAK to its team allows Dresser Industries to offer even greater service to the petroleum industry. The centrifugal contactor developed and manufactured by Podbielniak, newest of the Dresser companies, provides refinery operators substantially reduced costs, improved product quality, new marketable products, and increased profits.

TYPICAL PROFIT-MAKING APPLICATIONS OF THE PODBIELNIAK CENTRIFUGAL CONTACTOR:

- ★ Extracting aromatics from distillates, kerosene, jet fuel, etc., with liquid sulfur dioxide solvent.
- ★ Continuous separation of salt water from crude oils.
- ★ Extracting and purifying butadiene with CAA (cuprous ammonium acetate) solvent.
- ★ Sweetening of gasoline by continuous stream treating with caustic-cresol and other reagents.
- ★ Extracting undesirables (sludge forming aromatics and other unstable compounds) from lube oils to improve viscosity index while at the same time maintaining high yields, using solvents such as phenol, furfural, liquid sulfur dioxide, nitrobenzene and others.
- ★ Dewaxing and deasphalting of lube oil stocks.
- ★ Producing white oil and detergent additives for motor oils by continuous oleum reaction, followed by caustic neutralization and solvent extraction.
- ★ Removing sulfur compounds from catalytic cycle stock by means of continuous acid treating.
- ★ Water washing crude oils to remove corrosive salts prior to distillation.
- ★ Removal of phenols from waste waters using benzol and other solvents.
- ★ Recovering oils from tanker ballast while at the same time preventing harbor pollution.
- ★ Extracting aromatics from light cycle stock for the production of naphthalene.
- ★ Eliminating poisoning of reformer catalyst by removing impurities from naphtha charge stock.
- ★ Continuous acid treating of lube and specialty oils to improve oxidation stability, color, and decrease sludging tendencies, by eliminating impurities not removable by other solvent extraction processes.
- ★ Extracting aromatics from cycle stock to increase cat cracker capacity, cat gasoline yield and poly-gasoline production while at the same time reducing coke burning requirements and cat cracker investment.

CLARK

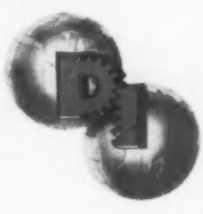
CLARK BROS. CO.
600 Lincoln Avenue
Olean, New York
• Engines • Compressors
• Gas Turbines

PACIFIC

PACIFIC PUMPS, INC.
5715 Bickett Street
Huntington Park, California
• Centrifugal Pumps
• Boiler Feed Pumps

ROOTS-CONNERSVILLE

ROOTS-CONNERSVILLE
900 West Mount Street
Connersville, Indiana
• Blowers • Compressors
• Gas Pumps • Rootsmeters
• Vacuum Blowers

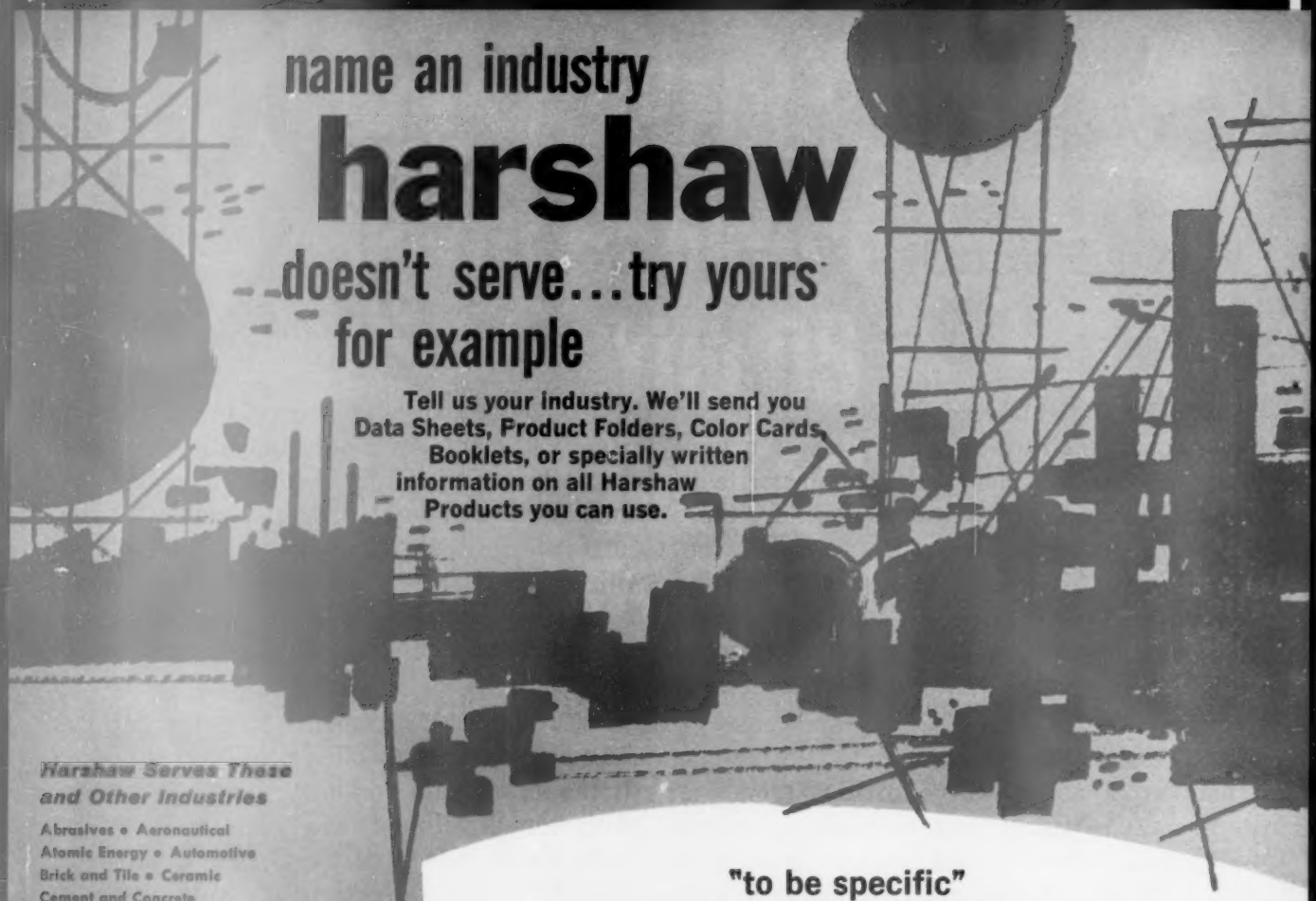


Podbielniak, Inc.

one of the Dresser Industries, Inc.

341 EAST OHIO STREET, CHICAGO 11, ILLINOIS

• PODBIELNIAK JOINS CLARK, PACIFIC AND ROOTS-CONNERSVILLE AS THE NEWEST MEMBER OF THE DRESSER TEAM SERVING THE REFINING INDUSTRY. •



name an industry
harshaw
doesn't serve...try yours
for example

Tell us your industry. We'll send you Data Sheets, Product Folders, Color Cards, Booklets, or specially written information on all Harshaw Products you can use.

Harshaw Serves These and Other Industries

Abrasives • Aeronautical
Atomic Energy • Automotive
Brick and Tile • Ceramic
Cement and Concrete
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Electrical Manufacturing
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Electroplating • Enamel
Engraving and Electrotyping
Explosive • Fat and Oil
Feed Stuff, Mineral Feed
Fertilizer • Food
Foundry • Glass
Insecticide and Fungicide
Laundry • Leather
Lithographing
Linoleum and Floor Covering
Lubricant • Match
Metallurgical • Metal Working
Oil Cloth • Optical
Paint, Varnish and Lacquer
Paper • Petroleum
Pharmaceutical • Photographic
Porcelain Enamel • Plastics
Pottery • Printing Ink
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Rubber • Soaps
Steel • Textile
Welding Electrodes
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"to be specific" Harshaw products for the
petrochemical industry

ANHYDROUS HF—As a catalyst in alkylation reactions (union of olefins to the paraffin, isobutane to produce alkylate); as a catalyst in other organic syntheses.

BORON TRIFLUORIDE—As a catalyst for isomerization, alkylation, polymerization, esterification, condensation.

CATALYSTS—For hydrogenation, dehydrogenation, and special synthesis.

METALLIC SALTS AND OXIDES—

Aluminum Nitrate	Cobalt Acetate	Nickel Nitrate
Cadmium Chloride	Cobalt Chloride	Zinc Nitrate
Cadmium Nitrate	Cobalt Hydrate	Nickel Formate
Cadmium Oxide	Cobalt Nitrate	Cuprous Chloride
Cadmium Sulfate	Copper Nitrate	Copper Oxide Black
Chromium Chloride	Manganese Hydrate	Copper Chloride
	Nickel Acetate	

HARSHAW

Harshaw Product Divisions:

Metal Organic Products, Antimony Oxide; Cadmium Pigments and Dispersions; Chrome and Organic Pigments; Catalysts; Ceramic Materials; Fluorides; Plating Processes; Anodes and Metal Salts; Stabilizers; Glycerine; Scintillation and Optical Crystals; Textile Products and Fine Chemicals; Miscellaneous Organic Products.

MAIL TO: THE HARSHAW CHEMICAL COMPANY
1945 East 97th Street, Cleveland 6, Ohio

Send data on Products for the _____ Industry.

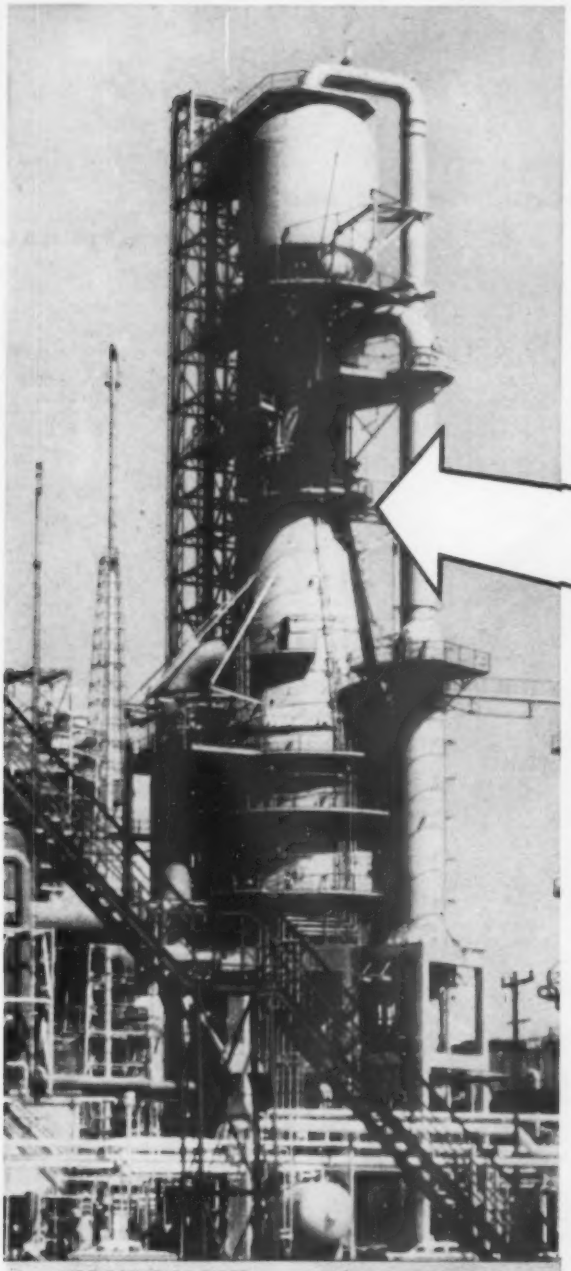
Name _____

Company _____

Address _____

City _____ Zone ____ State _____

At *CRITICAL* Valve Control Points



WIDE RANGE OF SIZES:

Screwed end ¼" through 3".

Flanged 150# series ½" through 12" — 300# ½" through 8".

Larger sizes on request.

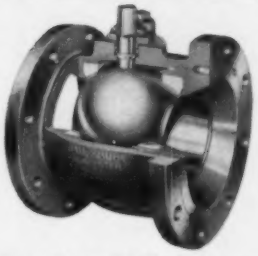
VARIETY OF MATERIALS:

Valves in 303 and 316 Stainless Steel, Alloy 20, Carbon Steel, Bronze, Ductile Iron, Monel, Aluminum and PVC. Interchangeable seats and seals in Teflon, Teflon compounds, Nylon, Buna-N, Neoprene, Hypalon and natural rubbers. Type DZ: Ductile Iron and Carbon Steel, Standard. Other materials on request.

...You Get Dependable Operation with

jamesbury "Double-Seal"™ BALL VALVES*

*PATENTED.



FIRE SAFE VALVING IN REFINERIES

The Jamesbury "Double-Seal" FIRE SAFE Ball Valve (Type DZ) has been accepted for use in the hydrocarbon industry because of its outstanding performance. In the event of fire – and the loss of the valve's soft seats, secondary metal seats provide effective shut-off of the fluid flow.

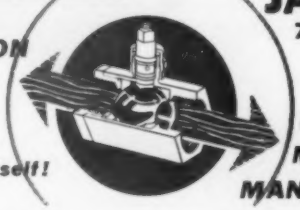
It stands to reason that a valve that performs outstandingly under adverse conditions can be relied on to give trouble-free performance under less severe conditions. That has been one of the big reasons, at least, for the success of Jamesbury "Double-Seal" Ball Valves. Proved dependable at *critical* valve control points, these valves have gone into industrial plants everywhere to control nearly all types of media flow.

There are many exclusive features about the Jamesbury "Double-Seal" Ball Valve which contribute to its excellent performance record. For example, there's Jamesbury's patented lip seal; there are no internal springs; you get leak-tight stem seals; operators are mounted integral with the valve. For further information about Jamesbury "Double-Seal" Ball Valves, contact your nearest stocking distributor – or write us direct.

Ask For Jamesbury Fluid Services Guide

JAMESBURY CORP.
79 New Street, Worchester, Mass.
DISTRIBUTORS IN PRINCIPAL CITIES

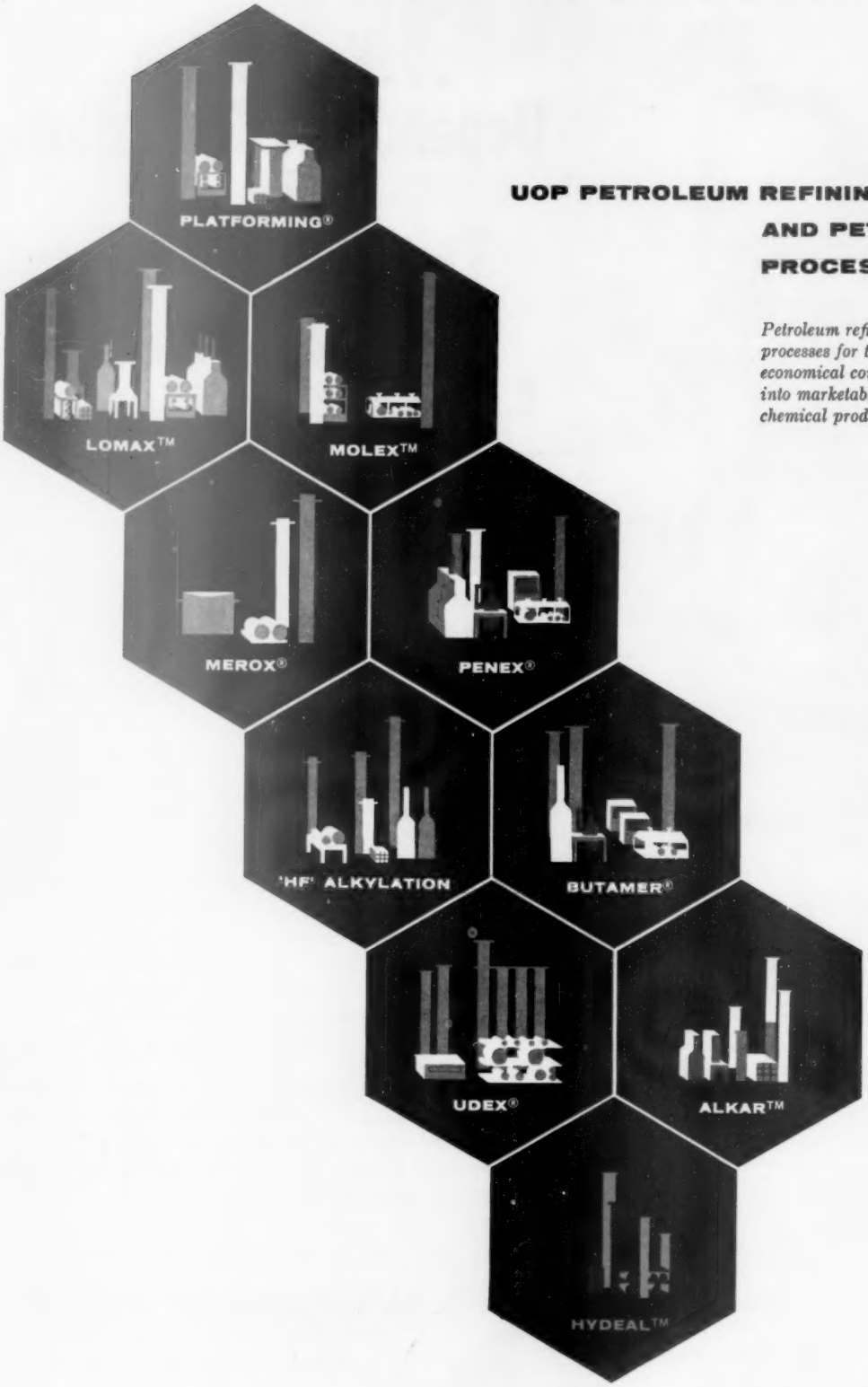
QUARTER TURN OPERATION
HIGH FLOW CAPACITY
ZERO LEAKAGE



NO LUBRICATION REQUIRED
MINIMUM MAINTENANCE
MANUAL OR POWER OPERATION

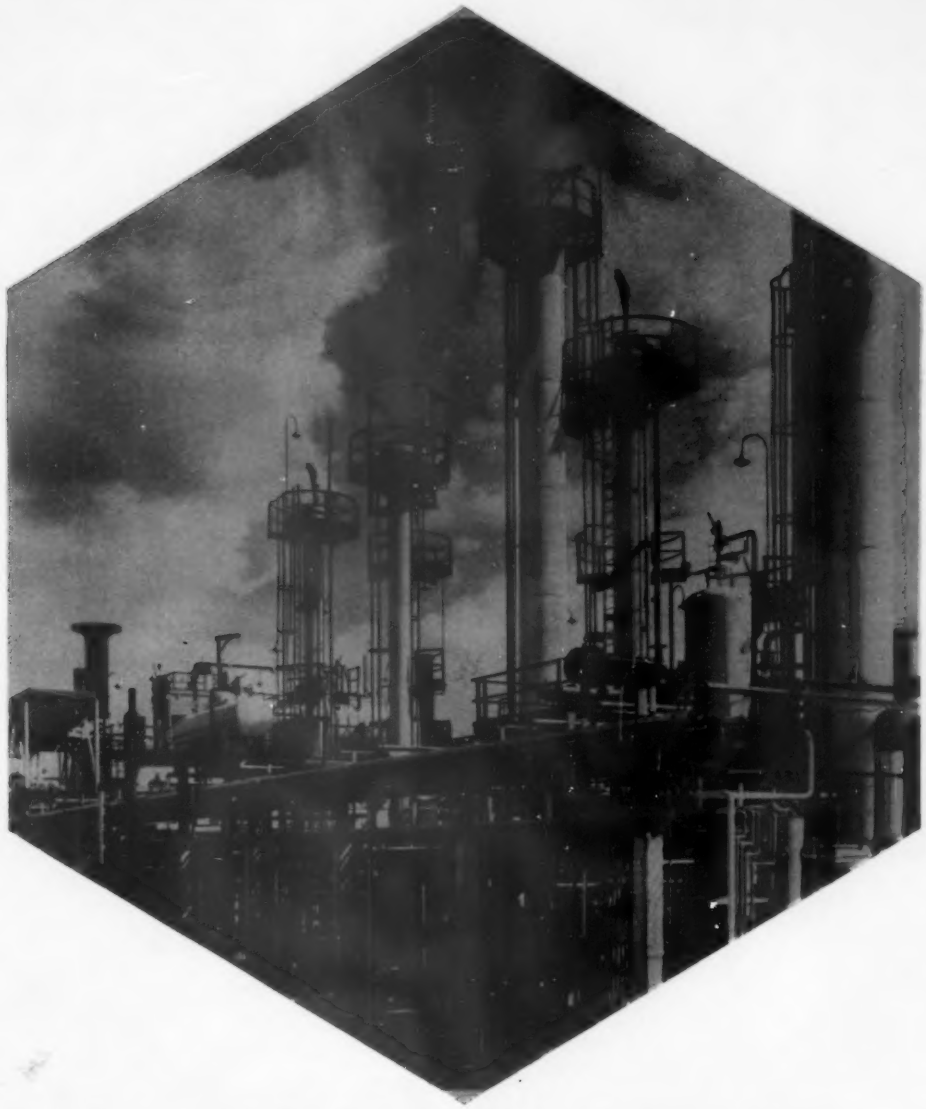
As Versatile As Industry Itself!

174-1 ©Jamesbury Corp. 1961



UOP PETROLEUM REFINING AND PETROCHEMICAL PROCESSES

Petroleum refining and petrochemical processes for the efficient and economical conversion of petroleum into marketable fuel and chemical products.



produce high-grade benzene with Hydeal™

HYDEAL, a new process for the catalytic hydrodealkylation of toluene or xylenes, produces benzene of exceptional purity. Hydeal is also efficiently employed in the production of naphthalene from higher-boiling alkylnaphthalenes.

Hydeal serves a unique marketing need in petrochemical processing. Toluene, xylenes and heavier aromatic mixtures can now be efficiently and profitably converted to higher valued nitration-grade benzene. Benzene market demands by 1968 are expected to grow to more than three times those of toluene and xylenes. Hydeal is ideally suited to meeting this projected growth in benzene demand.

Exceptionally efficient, the Hydeal process, jointly developed by Ashland Oil & Refining Company and UOP, provides excellent yields and operates at economical utility requirements. Benzene yield from the hydrodealkylation of toluene is over 90% of theoretical, while that from xylenes is over 85% of theoretical. Moderate in capital costs, Hydeal offers refiners a ready use for excess toluene and xylenes.

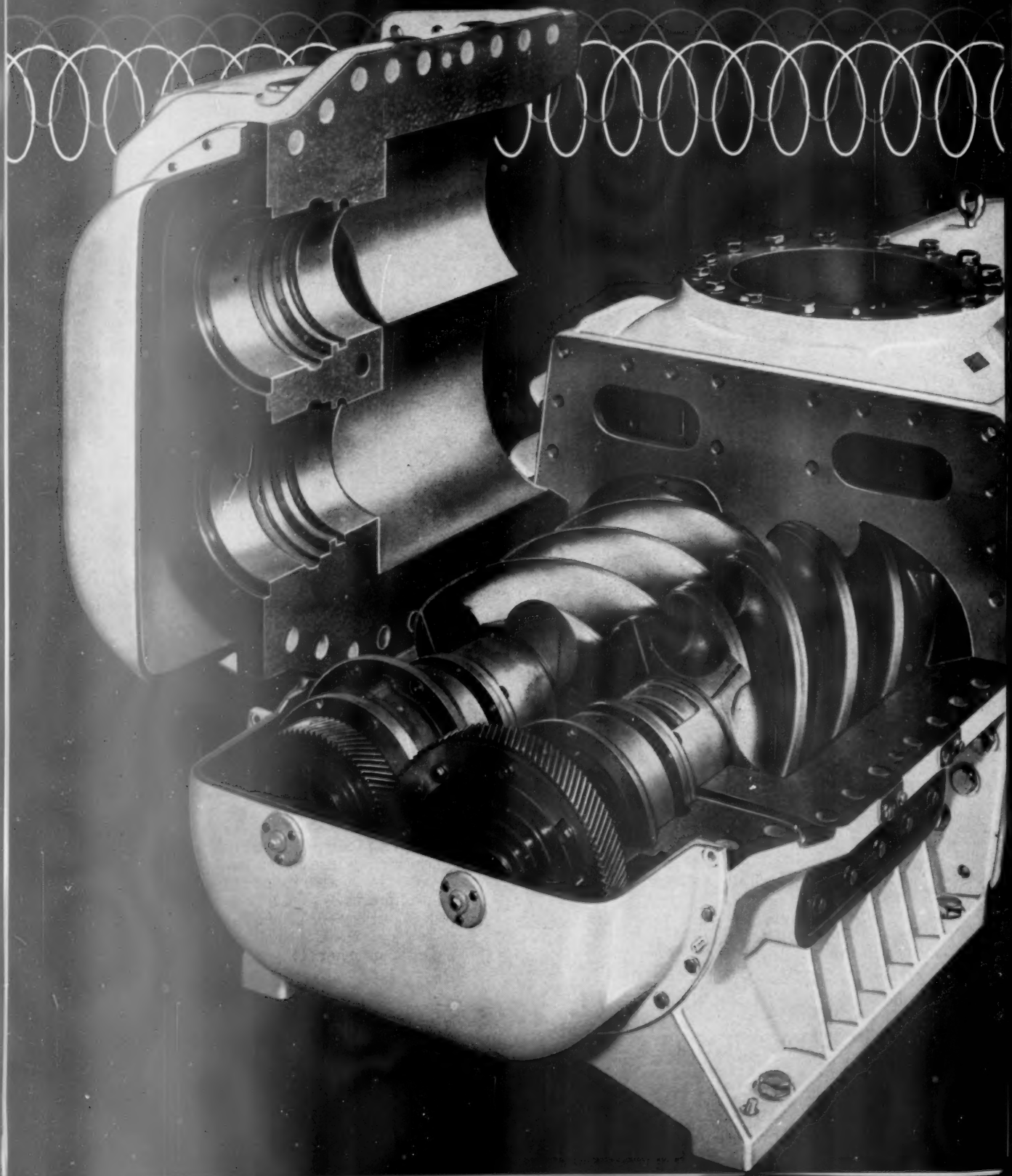
UOP offers a wide range of petroleum and petrochemical processes to refiners everywhere in the free world. A variety of technical sevices is also available to assure the profitable performance of these processes. Let us evaluate your processing needs now.

WHERE RESEARCH TODAY
MEANS PROGRESS TOMORROW

UOP

UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U.S.A.

MORE BLUE CHIP COMPANIES BUY F-M COMPRESSORS...



BECAUSE MECHANICAL SIMPLICITY MEANS FAR LESS COST!

F-M ROTARY COMPRESSORS

More and more, industrial leaders are looking-to (and buying) Fairbanks Morse leadership in Compressor design. Why? Because the unique, mechanical simplicity of this *rotary* design combines maximum efficiency and reliability with low initial cost—low maintenance requirements—minimum operating costs. *And skid-mounting* cuts installation time—puts you on stream faster.

The advanced design of the F-M Axial Flow Rotary Compressor features *helical-shaped* rotors for smooth, economical compression . . . with oil-free delivery, surge-free operation on a wide variety of gases.

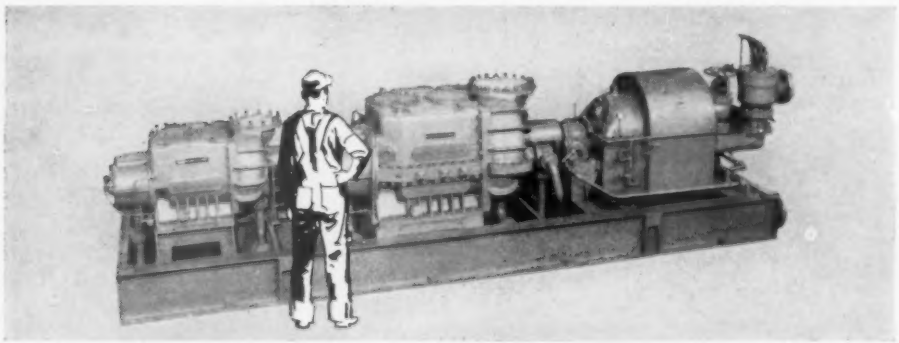
F-M Rotary Compressors have no reciprocating parts, no valves, no metal-to-metal contact in the compression chamber. Result? Minimum "down-time" expense. They save space—produce minimum vibration—provide stable performance with speed flexibility. Every Rotary Compressor built features famous Fairbanks Morse quality craftsmanship.

With capacities up to 21,000 cfm—and pressures up to 250 psig, F-M Rotary Compressors are a versatile asset to many operations. Discover how they can step up the efficiency of *your* operation . . . and cut maintenance and installation costs as well. Write: **Fairbanks, Morse & Co., Director of Marketing, Compressor Division: Beloit, Wisconsin.**

THESE INDUSTRIAL LEADERS HAVE BOUGHT F-M LEADERSHIP IN COMPRESSOR DESIGN!

(What Benefits Them Can Benefit YOU)

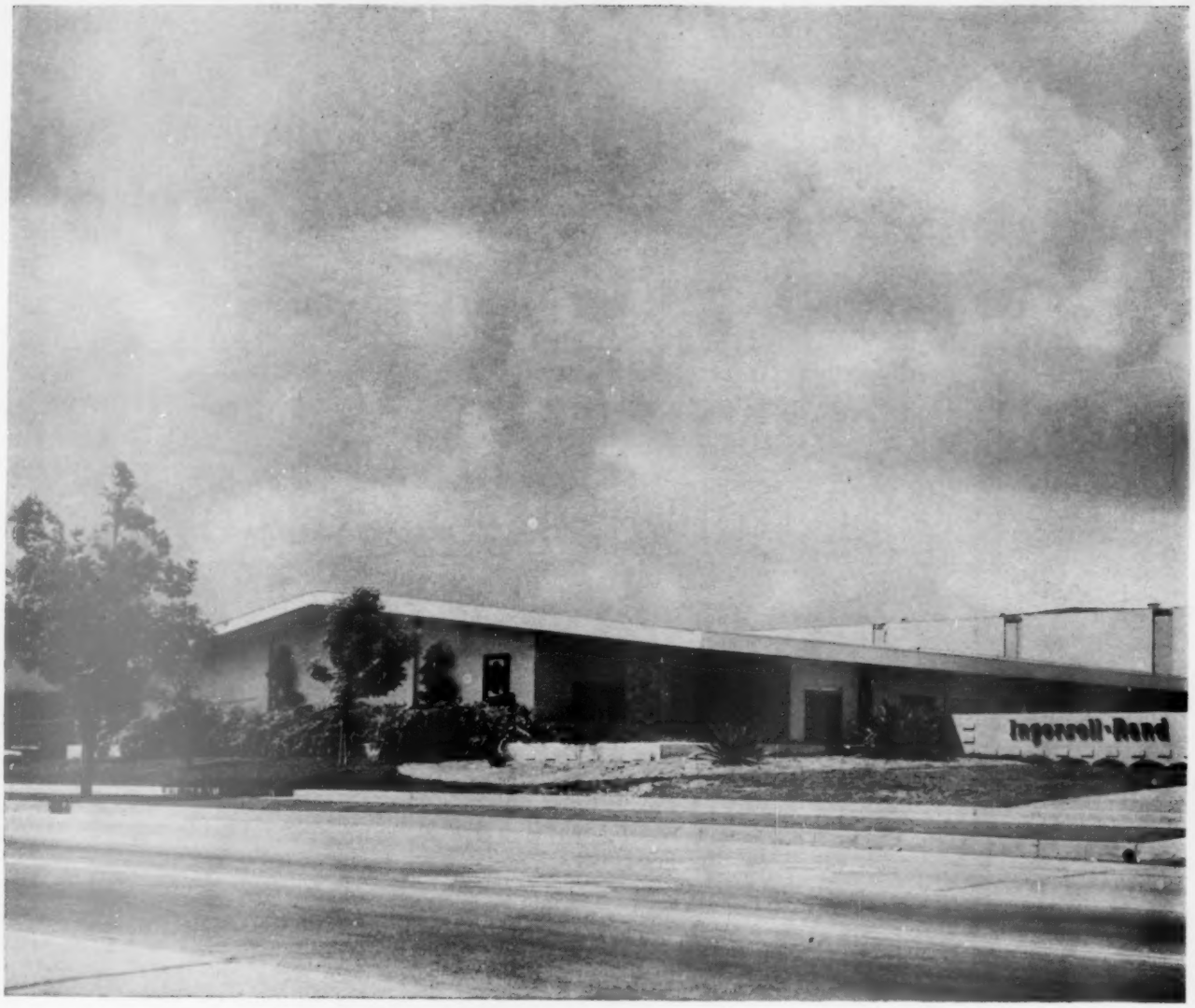
The Algoma Steel Corporation, Limited
American Metal Climax, Inc.
C F Braun & Co.
Celanese Chemical Co.
Copolymer Rubber & Chemical Corp.
Cyanamid of Canada, Ltd.
Deere & Company
Foster Wheeler Corporation
M. W. Kellogg Co.
Monsanto Chemical Co.
The Ralph M. Parsons Company
Phillips Chemical Co.
Scientific Design Co., Inc.
Shell Chemical Company
St. Paul Ammonia Products Co.
Union Carbide Chemicals Company
United Refining Co.



Skid-Mounted, Tandem Rotary Compressor ready for installation at Deere & Company, Waterloo Tractor Works.

Model 200L3/132L3 Fairbanks-Morse Rotary Air Compressor for 12,000 cfm, 110 psig. with 2600 h.p. steam turbine drive.

FAIRBANKS MORSE
A MAJOR INDUSTRIAL COMPONENT OF
FAIRBANKS WHITNEY



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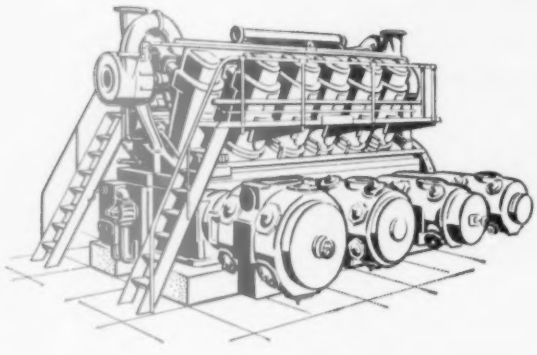

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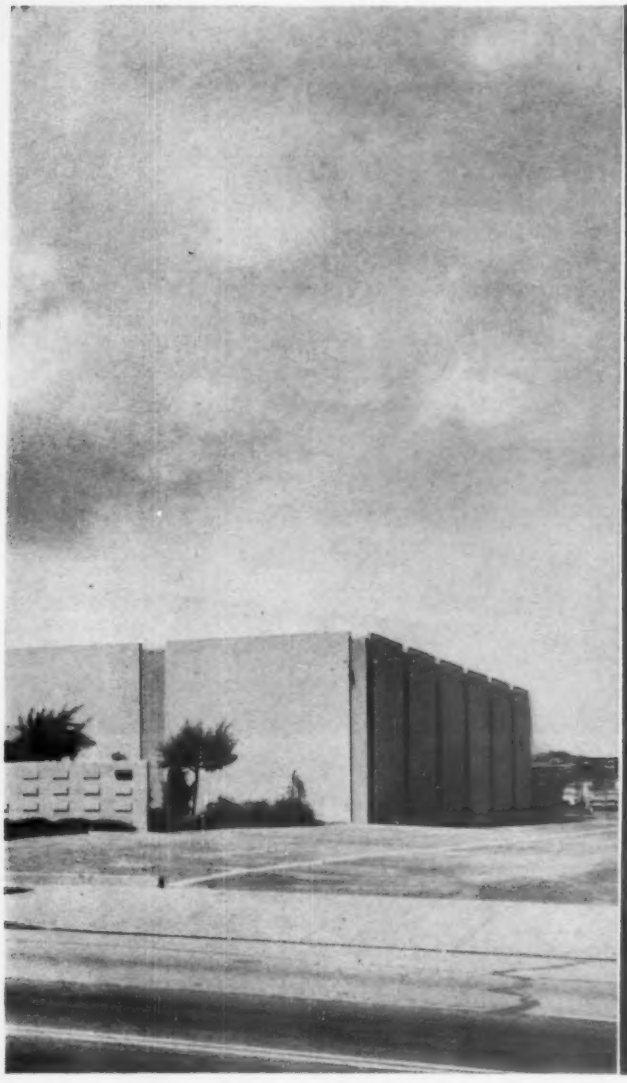

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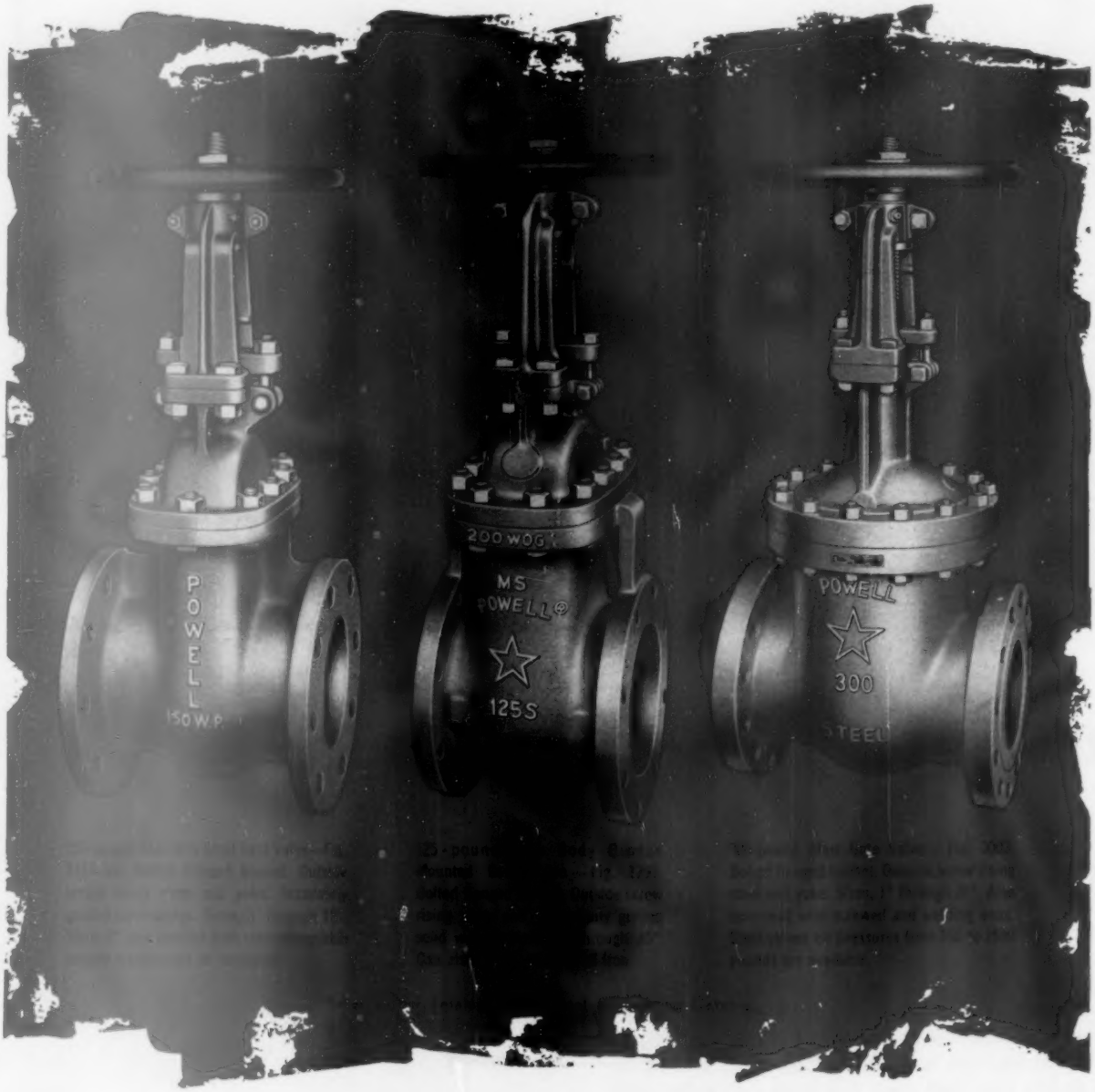

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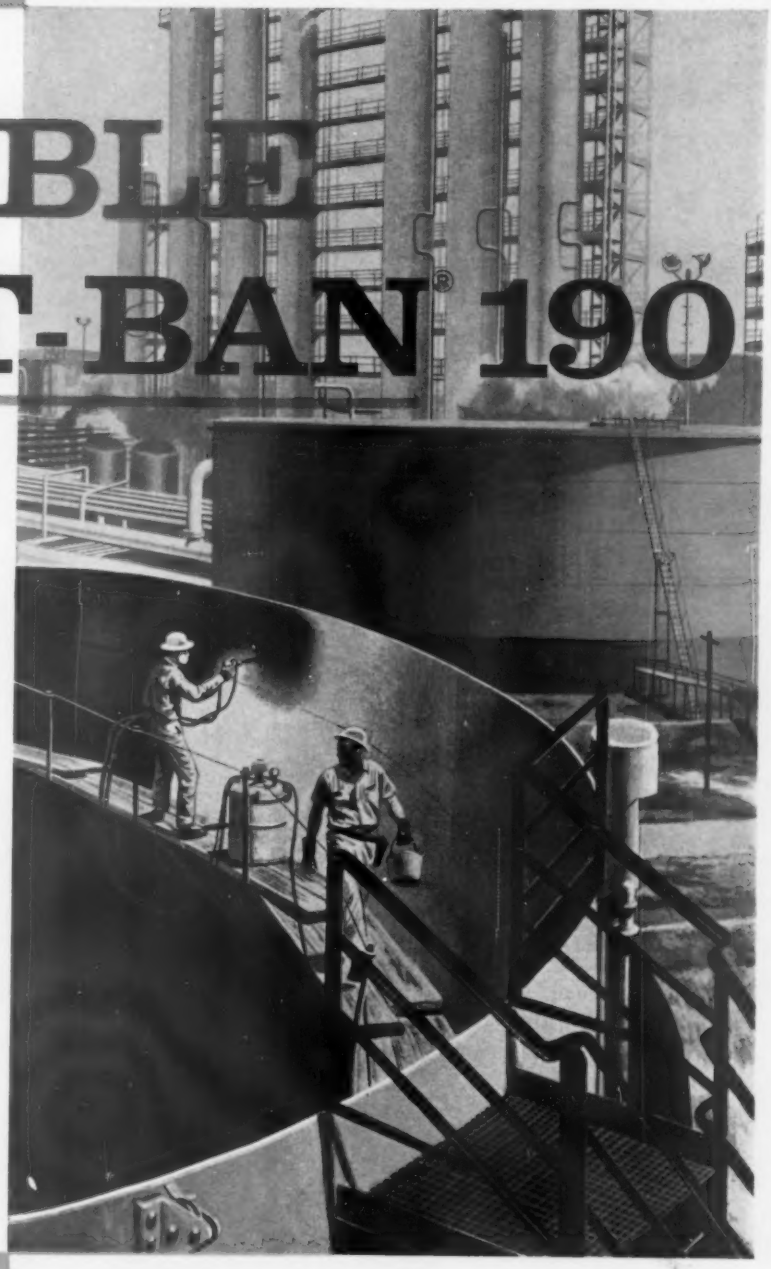

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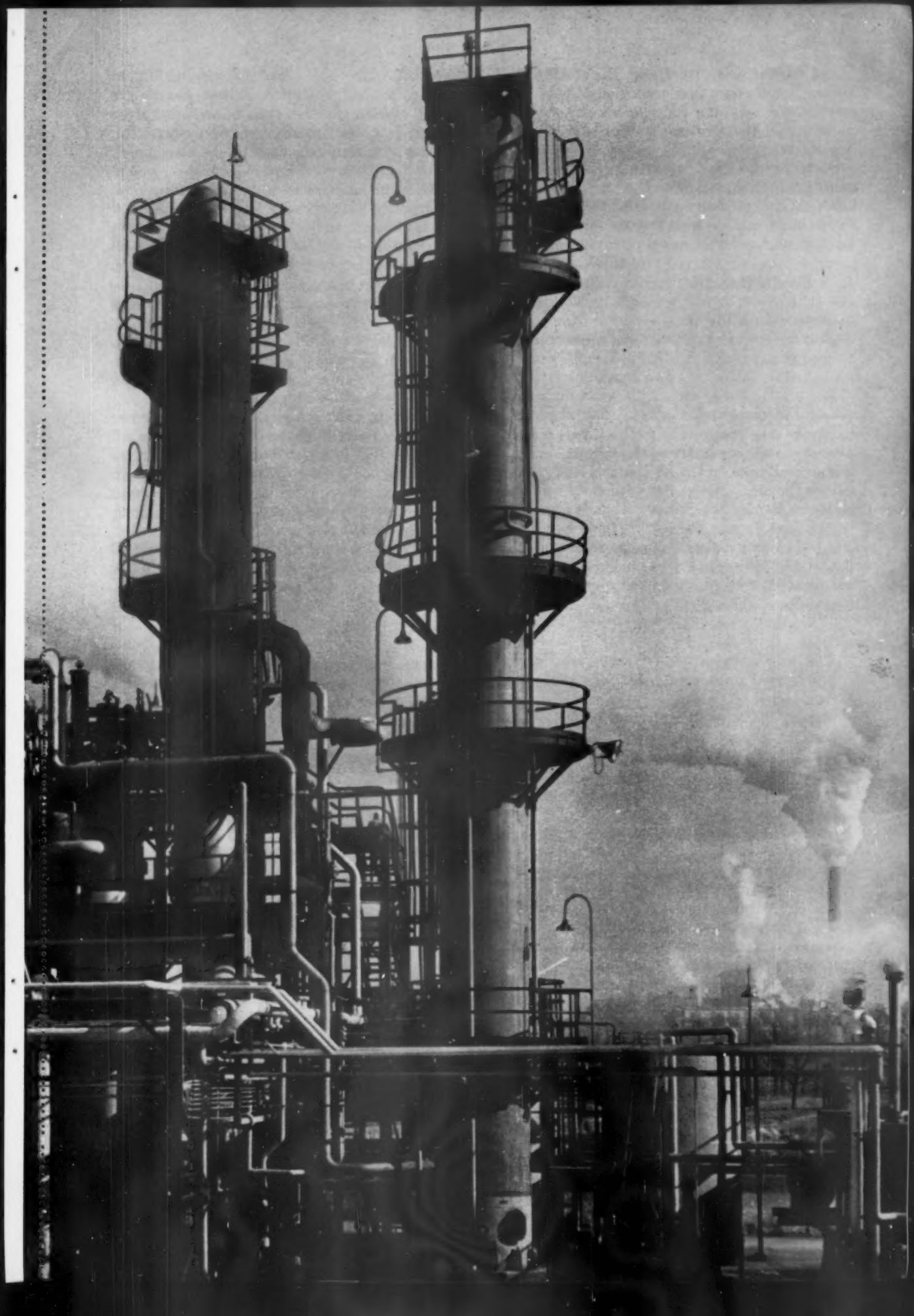
by Peter W. Sherwood

Oxidation Processes in HPI

Liquid-phase oxidation offers less drastic, more readily controlled synthesis conditions and higher selectivity than vapor-phase oxidation.

The liquid-phase approach (as practiced, for example in this Hopewell, Va., adipic acid plant of National Aniline Div., Allied Chemical Corp.) economically produces a number of oxygenated compounds that vapor-



phase oxidation forms only the difficulty. These liquid-phase-produced compounds are more stable, too, than under vapor-phase oxidation's higher temperatures and greater catalyst concentration.

Some of the most significant technical advances in petrochemical oxidation today are in liquid-phase processes. Table 1 lists some of the more important petrochemicals produced, at least in part, by this more versatile approach.

Production of Carboxylic Acid

Carboxylic acids are produced from either hydrocarbons or aldehydes by reaction with molecular oxygen in the liquid phase. The examples cited in Table 2 are of outstanding interest.

For production of carboxylic acids, oil-soluble cobalt and manganese salts are most versatile catalysts, applicable in almost every instance. Bromine compounds are used as promoters for manganese salts in the production of aromatic carboxylic acids in a process practiced commercially in the United States (Amoco), England (ICI) and Japan. Finally, chromium acetate has been mentioned prominently as catalyst for oxidation of lower aliphatics to acetic acid. This list does not claim to be all-embracive.

Acetic Acid

The production of acetic acid from butane is the largest single application of liquid-phase air oxidation techniques.

Among the several catalysts which have been described for processes in this category, good acetic acid yield has been reported for the use of manganese acetate (76% yield), cobalt acetate (62% yield) and chromium acetate.

The liquid-phase oxidation of butane must be carried out at elevated pressure and in the presence of a solvent. Acetic acid, itself the main product of the reaction, is a suitable solvent for this purpose.

Loder[1] indicates the reaction is most suitably carried out at 125 to 200 C. His patent covers numerous catalysts, among which cobalt acetate appears particularly active. As is frequently the case in liquid-phase oxidation reaction, there is an incubation period which may be essentially eliminated by addition of a peroxide as initiator.

Mitchell and Luke[2] used 1300 parts glacial acetic acid (as solvent) containing 0.3 wt % chromium acetate. Into this reaction medium, liquid n-butane and air were introduced separately in the ratio 1:4.7. Operating temperature was 165 to 170 C and pressure was 815 psia.

Overhead vapors were cooled to 5 C and the condensate allowed to stratify. For maximum acetic acid yield, the hydrocarbon phase is recycled directly to the reactor without prior extraction of contained oxygenated by-products. Acetic acid is recovered from the aqueous phase. Under the conditions described, 100 lb of butane shows an ultimate yield of 103.7 lb acetic acid, 6.4 lb methyl acetate, 2.4 lb ethyl acetate, 1.0 lb ethyl alcohol and 4.5 methyl ethyl ketone.

Oxidation of acetaldehyde to acetic acid can be guided to the preferential formation of acetic acid or of its anhydride. For acetic acid production, manganese acetate is the preferred catalyst. Typical operating conditions are 0.13 wt % catalyst introduced with the incoming liquid acetaldehyde, 50 to 70 C reaction temperature and 20 to 30% conversion per pass. Yield of 95 to 96% of theory can be obtained.

Operating pressure is fixed by the need to recover acid and aldehyde from the reactor tail gas; thus it is dependent on refrigeration economics and on the question of whether air or oxygen is used. With oxygen, a pressure of 45 psig permits adequate aldehyde recovery from the reactor tail gas by means of a water-cooled condenser. Installations using air normally call for a system pressure of 100 to 150 psig and call for water-scrubbing of the tail gas.

Trend Toward Oxygen

In general, the trend in acetaldehyde oxidation plants is away from air and toward oxygen.

By a modification of conditions, acetaldehyde may be oxidized to a mixture of acetic anhydride and acetic acid in ratios as high as 60:40. This version of the reaction is also carried out

TABLE 1.

Oxidizing Agent	Product: Carboxylic Acids	Product: Carbonyl Compounds and Alcohols	Product: Other
Air or oxygen	Acetic Butyric	Acetaldehyde Acetone	Hydrogen peroxide Cumene hydroperoxide
	Benzoic Phthalic Isophthalic Terephthalic Toluic Trimellitic Peracetic Adipic Mixed fatty acids	Methyl ethyl ketone* Methyl isobutyl ketone* Acetophenone Cyclohexanol Cyclohexanone	Propylene oxide* Sulfur*
Nitric acid	Adipic Terephthalic		
Sulfur and other	Isophthalic Terephthalic Phthalic* Benzoic*		Hydrogen peroxide Higher epoxides

*Process in development stage.

in the liquid phase but uses a catalyst consisting of cobalt acetate and copper acetate in a weight ratio of 2:1.

Two commercial methods of operation have been reported. In one of these, ethyl acetate serves as diluent. Catalyst concentration is 1 wt %. The reaction is carried out at 50 C and 30 psig. Oxygen is injected at various points along the path of liquid travel. Overall oxygen supply is controlled at about 1 to 2% in excess of stoichiometric requirements.

Per-pass conversion is almost complete; only some 2 to 4% of the acetaldehyde charge appears in the crude oxidation product. Typically, the production of 1000 lb of 95% acetic anhydride consumes 1680 lb acetaldehyde, and yields 1050 lb acetic acid as co-product.

Using the same catalyst system in the absence of diluent, a lower ratio of acetic anhydride to acid is obtained. This drawback is largely offset by the higher oxidation rates which are possible at these operating conditions, and this version of the process is also commercial.

A typical charge consists of 1600 lb acetaldehyde, 20 lb cobalt acetate, 10 lb copper acetate and 270 lb acetic acid-anhydride mixture. Oxygen is used as oxidizing agent. The reaction is carried out at 50 to 55 C and 35 psig. The product contains, on a catalyst-free basis, 35 to 40% acetic anhydride, 49 to 55% acetic acid and 8 to 10% water, plus minor amounts of acetaldehyde and methyl acetate.

Production of peracetic acid by acetaldehyde oxidation is practiced by Union Carbide Corp. While details of the commercial process have not become available, it is clear that none of the usual oxidation catalysts are applicable, since they cause the rapid decomposition of peracetic acid to acetic acid.

In the presence of ultraviolet light, acetaldehyde can be air-oxidized to peracetic acid. Actually, this acid appears to be present in the form of acetaldehyde monoperacetate which is stabilized by the presence of solvents, such as acetic acid or ethyl acetate.

Because of the peracetate's low thermal stability, the oxidation reaction must be carried out at low temperature. Oxidation of acetic acid-diluted acetaldehyde at —5 to 0 deg C in the presence of ultraviolet light permits per-pass conversion of some 50 to 60% of the aldehyde to acetaldehyde monoperacetate; ultimate yield is nearly quantitative.[3]

TABLE 2.

Product	Raw Material	Typical Catalyst	Commercial Status
Aliphatic Acids			
Acetic acid	Butane	Manganese, cobalt, chromium salts	Commercial
	Acetaldehyde	Cobalt acetate	
		Manganese acetate	Commercial
	Ethanol	Cobalt acetate	Not commercial
Peracetic acid	Acetaldehyde	Ultraviolet light	Commercial
Butyric acid	Butyraldehyde	Manganese acetate	Commerical
Adipic acid	Cyclohexanol-cyclohexanone	Cobalt naphthenate	Not commercial
Mixed fatty acids	Medium-range paraffins	Potassium permanganate	Commercially inactive
Aromatic Acids			
Benzoic	toluene, ethyl benzene	bromine-promoted manganese salts	Commercial
Phthalic	o-xylene		
Isophthalic	m-xylene		
Terephthalic	p-xylene	ketone-promoted cobalt salts	Not commercial
Trimellitic	Pseudocumene		
Terephthalic acid	p-diisopropyl benzene	Mixed cobalt and manganese acetate	Pilot plant
Toluic acids	Xylenes	Cobalt toulate	Commercial

Aromatic Acids

The three isomeric phthalic acids as well as trimellitic acid may be produced from the corresponding polymethyl benezene by liquid-phase oxidation.

Of particular interest is the catalytic use of bromine compounds in conjunction with salts of variable-valence heavy metals such as manganese or cobalt. The reaction may be carried out without solvent, but advantages have been reported with use of a solvent, such as acetic acid.

The process is of importance in the production of para-substituted polycarboxylic acids, notably terephthalic and trimellitic acids, since the air oxidation of a methyl group in para-position to a carboxyl group is notoriously difficult by other means. According to Burney[4] the oxidation of p-xylene in the presence of bromine-promoted manganese salts proceeds with a conversion above 95% and with a terephthalic acid yield in excess of 80%.

Using only cobalt toluate as catalyst, air oxidation of p-xylene may be employed as first step in terephthalic acid synthesis, yielding toluic acid as intermediate.. The reaction is carried out in the liquid phase at about 200 C. Product toluic acid is esterified with methanol, and the resulting methyl toluate is further oxidized either by nitric acid or by air oxidation in the liquid phase. Basis of the latter approach is the finding that oxidation of toluic acid proceeds more readily if the carboxylic group is tied up.

Not yet commercial, but potentially important is the recently described[4] liquid-phase oxidation of p-xylene to terephthalic acid by oxygen in the presence of cobalt acetate promoted by methyl ethyl ketone. The reaction mixture must be diluted by a large volume of acetic acid containing some water. Terephthalic acid yield

as high as 95% is reported. Yields near 90% were obtained in oxidizing toluene and m-xylene to the corresponding carboxylic acids.

Carbonyl Compounds, Alcohols

Liquid-phase oxidation of the lower olefins to produce carbonyl compounds is a recent development of Consortium fur Elektrochemische Industrie (a joint subsidiary of Farbwerke Hoechst and Alexander Wacker).

The method permits conversion of ethylene to acetaldehyde. Oxidation of propylene and higher olefins leads to the corresponding ketones. Two large-scale acetaldehyde plants, based on the Consortium process, are to go onstream during early 1961 at Cologne and Frankfurt, Germany. Synthesis of acetone, methyl ethyl ketone and methyl isobutyl ketone by this route is under development.

In the Consortium process, an aqueous solution of palladium chloride, promoted by copper chloride or iron chloride, serves as oxygen carrier. The conversion consists of two main reaction stages which may be carried out simultaneously or in separate converters:

- Reaction of olefin with palladium chloride to yield the desired carbonyl compound plus metallic palladium and hydrogen chloride.
- Oxidation of metallic palladium in the presence of hydrogen chloride to reconstitute palladium chloride. Oxygen or air is the oxidizing agent for this reaction, and copper chloride serves as catalyst.

Several process schemes have been described by Smidt.[5] Their essential differences are: single-stage vs two-stage reaction, and air vs oxygen as oxidizing medium.

Despite its higher investment, a two-stage system offers a number of advantages, especially when air is the oxidizing agent. Such a scheme permits separate control of the two reaction steps and reduces the explosion hazard. The product carbonyl is stripped from the catalyst solution at a point preceding the air oxidation stage.

For optimum performance, Smidt calls for operation at a pH between —1 and +2 in the metal oxidation step. The olefin oxidation is effected at or near 100 C and at moderately elevated pressure. In ethylene oxidation, yield is reported at 90% of theory.

Acetophenone, produced by the liquid-phase oxidation of ethyl benzene, is an intermediate in a method of styrene synthesis which is still practiced at Union Carbide's Institute, W. Va., plant. This route to styrene is competitive with the much more important direct dehydrogenation of ethyl benzene only to the extent that by-product acetophenone and methyl phenyl carbinol sales provide adequate revenues. However, markets for those co-products are fairly limited and they are also available as by-products of liquid-phase oxidation of C^8-aromatic fractions (in the production of mixed phthalic acids) as well as of cumene (in cumene hydroperoxide synthesis).

For the preferential air oxidation of ethyl benzene to acetophenone, manganese acetate serves as catalyst. Operating pressure is 30 psig. The temperature is controlled at 126 C and contact time has been reported at 1.5 hr. Only limited conversion per pass can be taken, because of declining reaction rate, and the liquid reactor effluent contains 70 to 75% unconverted ethyl benzene.

Union Carbide employs two acid-brick-lined reactors in series. Low product concentration in the first reactor permits high conversion rates. The reaction is continued, at substantially reduced rate, in the second converter. Over-all yield in the two units is reported at 88% acetophenone plus methyl phenyl carbinol. Typical composition of the effluent from the reactor system is 73% ethyl benzene, 17% acetophenone, 8% phenyl methyl carbinol and 2% by-products.

Cyclohexanol

Cyclohexanol, together with its derivative cyclohexanone, has its importance as intermediate in the production of adipic acid, hexamethylene diamine, and caprolactam, all of which are consumed in the production of the two major grades of nylon, Nylon-6 and -66.

While cyclohexanol is also produced by hydrogenation of phenol, liquid-phase oxidation of cyclohexane has become the paramount commercial method of synthesis. More specifically, this oxidation process yields a mixture of cyclohexanol and cyclohexanone. This may be used, as is, as feed in the nitric acid oxidation to adipic acid. If the end purpose is manufacture of caprolactam, however, only cyclohexanone is of interest. In this case, the ketone can be recovered from the crude oxidation or the contained cyclohexanol can be converted to its ketone.

Of the various catalysts for cyclohexane oxidation, best results are reported for oil-soluble cobalt salts, such as cobalt naphthenate. The reaction is carried out at 125 to 165 C and a corresponding total pressure (50 to 25 psi). By-product water is continuously removed from the system by azeotropic entrainment. Operating a multi-autoclave system in series at 15 to

20% conversion, these conditions permit a 60 to 75% yield of (pure) cyclohexanol and cyclohexanone, but the yield of total products convertible to adipic acid is 80 to 85% of theory[6].

Miscellaneous Products

Two peroxides, namely cumene hydroperoxide and, to a lesser extent, hydrogen peroxide, are large-volume petrochemicals obtained by liquid-phase air oxidation techniques.

The importance of cumene hydroperoxide rests in its position as intermediate in a method for the production of phenol and acetone which accounted for somewhat less than 20% of U. S. phenol capacity installed as of early 1961.

The process has been previously discussed by the author in this journal[7]. Either air or oxygen may serve as oxidizing agent. Oxygen has the advantage of carrying less cumene from the reactor and permitting higher throughput per unit reactor volume.

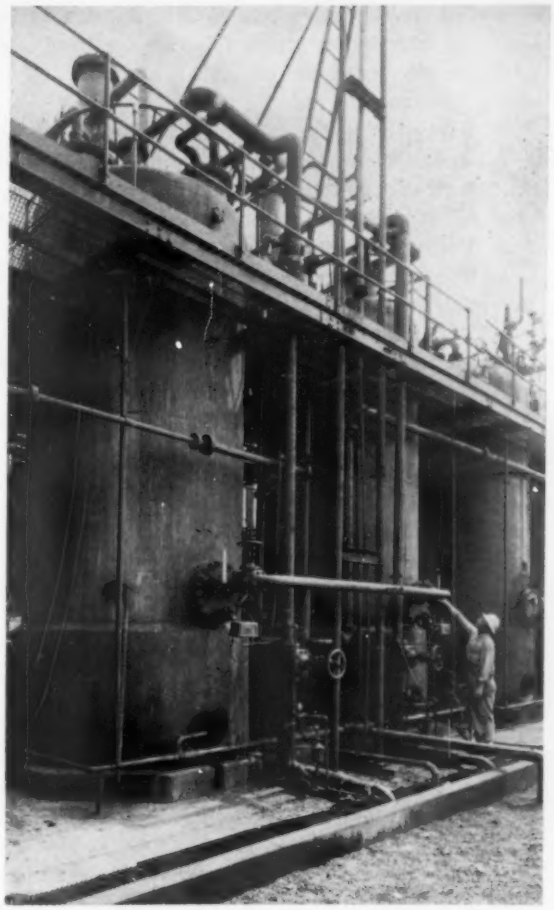
While several types of catalyst have been recommended for the oxidation of cumene to its hydroperoxide, industrial execution is limited to the use of alkaline compounds, such as sodium carbonate. These materials should be thought of less as catalysts than as agents to control pH at its optimum value of 8.5 to 10.5.

An emulsion technique of cumene oxidation is industrially significant. Aqueous solution of sodium carbonate is thoroughly agitated with cumene in the presence of an emulsifying agent, and air is passed through the mixture. Typically, the reaction is carried out in four successive converters. For example, the following temperature-conversion stages may be employed:

Reactor Number	Temperature, deg C	Cumene hydroperoxide content of reactor effluent, %
1	120	10
2	117	15
3	115	20
4	110	27

Such graded operation permits use of the highest temperature in the early stages where product decomposition is not yet a series factor. The reaction is normally carried out at pressures between 60 and 200 psig, depending on operating temperature.

Product leaving the oxidation reactors contains some 65 to 75% unconverted cumene. The bulk of this is vacuum-stripped, leaving a crude material with 75 to 85% cumene hydroperoxide to be charged directly to the decomposition stage where it is converted to phenol and acetone by acid-catalyzed splitting.



Reactors for partial oxidation of ethyl benzene. Photo courtesy of Carbide and Carbon Chemicals.

Hydrogen Peroxide

Liquid-phase oxidation of isopropanol may be guided to the coproduction of hydrogen peroxide and acetone. A plant based on this approach is operated by Shell Chemical Co. at Norco, La.

This reaction is autocatalytic; i. e. hydrogen peroxide itself promotes it. To eliminate a lengthy incubation period, about 1 wt % hydrogen peroxide is fed to the reactor together with the alcohol. From 80 to 95% oxygen has been suggested as preferred oxidizing agent. Operation is at 90 to 140 C and at 200 to 300 psig.

The material of construction is critical. None may be selected which promotes the decomposition of hydrogen peroxide, as will nickel, iron, steel, etc. Good experience is reported for glass, acid enamels, aluminum, tin and organic coatings.

Hydrogen peroxide concentration is allowed to build up to 15 to 25 wt % in the product stream which is withdrawn continuously from the reactor. This stream must be water-diluted to 6 to 10% strength before distillation to avoid

an explosive condition due to simultaneous presence of high concentrated hydrogen peroxide and organic compounds. Also added at this stage are stabilizers.

At first step in the recovery process, acetone and unconverted isopropyl alcohol are distilled off. Further purification is effected by ion exchange (to remove contained heavy metals) and finally by distillation.

In one series of experiments, carried out at a per-pass alcohol conversion of 15%, reactor yield of acetone was 93% on alcohol. Including purification, overall yield of hydrogen peroxide was 87% on isopropyl alcohol.

Propylene Oxide

Propylene oxide is produced commercially only via the chlorohydrination route. Attempts to parallel the successful vapor-phase oxidation of ethylene have not led to a feasible process for propylene oxide synthesis. Better results are obtained by subjecting propylene to liquid-phase oxidation.

Some details on liquid phase oxidation are provided by Gardner[8]. In his process, the oxidation is carried out in benzene; manganese propionate is the catalyst, and air is the oxidizing agent. A critical requirement for good yield is the maintenance of low propylene oxide and water concentration in the solvent. Toward this end, a sidestream of reaction medium is circulated continuously between the converter and a stripper. En route, acids formed during the oxidation are neutralized to minimize hydrolysis. As a further refinement, Robertson[9] claims that propylene oxide yield can be raised by adding propane to the propylene feedstream. Typical reaction conditions are 175 to 225 C and 300 psig, with oxygen:propylene:propane ratio of about 1:1:1.

At these conditions, Robertson reports the following products per 100 grams of hydrocarbon consumed: 39.8 grams propylene oxide (28.5% of theory); 22.9 grams propylene glycol (12.6%); 19.3 grams C_1 to C_4 acids; 12.3 grams polymeric meterials; 68.1 grams carbon oxides, and 30.3 grams other products.

Sulfur from hydrogen sulfide is produced commercially by catalytic vapor-phase oxidation (see Part 1, Feb. '61). During 1959, Atlantic Refining Co. announced a process for liquid-phase oxidation of H_2S to elemental sulfur, using aqueous ferric chloride chelates as oxygen carrier. A liquid-phase method for reacting sulfur dioxide with hydrogen sulfide to yield elemental sulfur is described by Townsend[15], who calls for use of an aqueous solution of triethylene or diethylene glycols as reaction medium. This approach is a modification of the reaction which is normally carried out in the vapor-phase (see Part 1).

Part I — Vapor Phase Processes appeared in the February, 1961 issue of Petro/Chem Engineer. Bibliography for both Parts I and II are given here.

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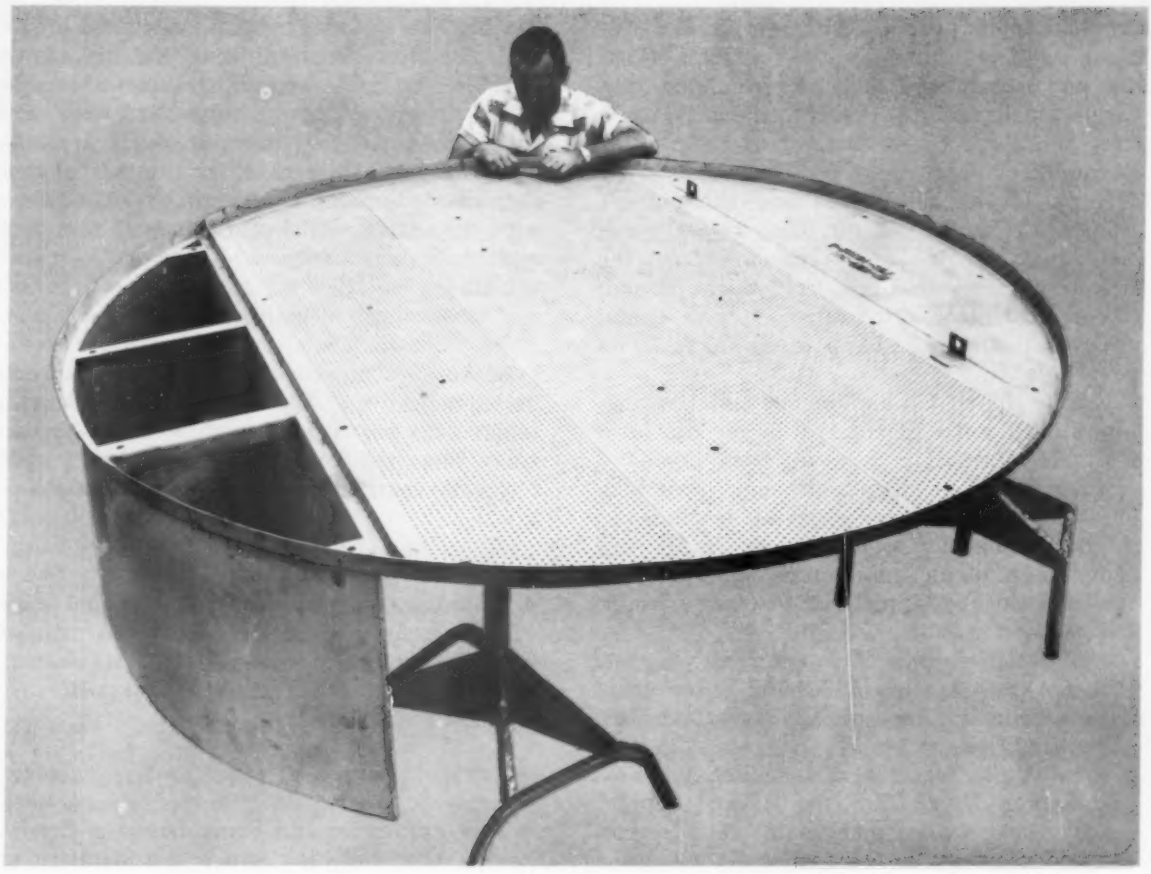

Photo Courtesy Fritz W. Glitsch & Sons, Inc., Dallas, Texas

How to Predict Sieve Tray Entrainment and Flooding

by Dr. James R. Fair

With a new general method of predicting entrainment and flooding, the design engineer now can capitalize on the advantages of sieve trays.

These perforated trays with downcomers have become well known and widely used in recent years for efficient vapor-liquid contacting. For many applications they are superior to the popular bubble-cap trays.

In addition to their lower cost, lower pressure drop and simpler maintenance, sieve trays feature increased vapor handling capacity and its corollary, decreased entrainment.

Flooding on a sieve tray may be caused either by excessive entrainment or by liquid backup in the downcomer. The true point of flooding is difficult to determine experimentally, and "maximum capacity" is usually synonymous with an incipient flooding condition brought on by either of the two phenomena noted above.

When downcomers are adequately sized, "entrainment-flooding" is more likely to occur. Observations show that downcomers may be only partly filled with liquid when such flooding begins. (As flooding develops further, of course, downcomers begin to fill.) Although only entrainment-flooding, i.e., vapor capacity, is considered in this article, the designer should also consider downcomer backup, i. e., liquid capacity.[3,21]

A number of experimental investigations of sieve tray entrainment have been conducted in

simulator units (usually with air) or in distillation columns. Equipment type, scale of operation and entrainment collection technique have varied widely and are subject to the usual problems of interpretation in light of their effect on commercial operations.

Hunt, Hanson, and Wilke[16] made entrainment studies in a small simulator, using several gases and liquids. Their work is valuable from the standpoint of system property effects, though the equipment was too small to give useful design data and, in addition, there was no liquid flow to the tray.

Brook, Honnold, Cunningham and Huntington[4] studied entrainment in a larger simulator with air contracting three different liquids.

Their data is important, although vapor velocities were considerably short of flooding.

Friend, Lemieux, and Schreiner[11] made very complete simulator studies of the air-water system and elucidated many of the tray variable effects on entrainment.

Distillation studies of Jones and Pyle[17] and Kirschbaum[20] provide additional entrainment data taken under commercially important operating conditions.

Finally, the papers of Mayfield et al,[23] Foss and Gerster,[10] and Giles, Dryden and Lapple[13] supply background experimental data for correlation purposes.

No generalized correlations of sieve tray flooding and entrainment have appeared previously. Previous articles dealing with sieve tray design,[8,14,15,21] have suggested using allowable vapor velocities from Souders and Brown,[27] with a consequent unknown approach to flooding. The small-scale work of Hunt et al has been adapted, with some question, for use either with sieve trays or bubble-cap trays.[1] No other related work has been done.

Flooding

Because of the proportionately greater work on bubble-cap tray flooding, it is convenient to relate sieve tray studies to those of bubble-cap trays. Thus, the flow parameter previously used for other contracting devices[2,26] is adopted:

$$\text{Flow parameter} = \text{FP} = \frac{L}{G}\sqrt{\frac{\rho_V}{\rho_L}} \quad . \; . \quad (1)$$

This parameter accounts for liquid flow effects on the tray, and in reality is a ratio of liquid/vapor kinetic energy effects. For a capacity parameter, the familiar Souders-Brown[27] coefficient is retained:

$$C_{SB} = U_N\left(\frac{\rho_V}{\rho_L - \rho_V}\right)^{1/2} . \; . \; . \; . \quad (2)$$

This parameter has some basis in theory, having been derived from a consideration of droplet suspension in a gas stream. The vapor

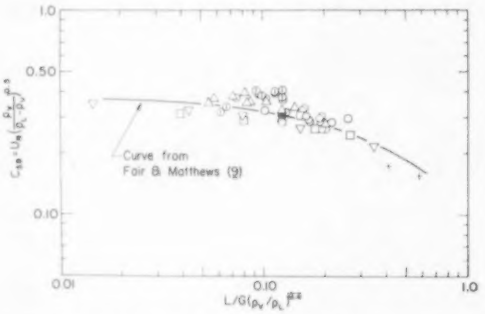

FIG. 1. Bubble-cap tray flooding, 24-in. tray spacing.

TABLE 1. Studies of Bubble-Cap Tray Flooding. (24-in. Tray Spacing)

Symbol (Fig. 1)	Investigator	System	Tower diameter (in.)	Surface tension (Dynes/cm)
▽	Manning et al[22]	Toluene/Iso-octane	60	20
□	Muller & Othmer[24]	Nitrogen/Absorption Oil	66	26
△	Fractionation research[2]	Cyclohexane/n-Heptane	48	12
◫	Gerster et al[9]	Acetone-Benzene	24	13–20
○	Clay et al[5]	Isobutane/n-Butane	36	8–10
●	Kelley et al[19]	Cracked gas fractionation	192	17
+	Kelly[18]	Refinery gas absorption	90	22

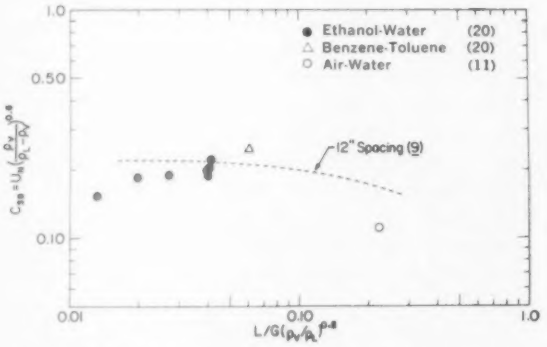

Fig. 2. Sieve tray flooding, 6-in. tray spacing.

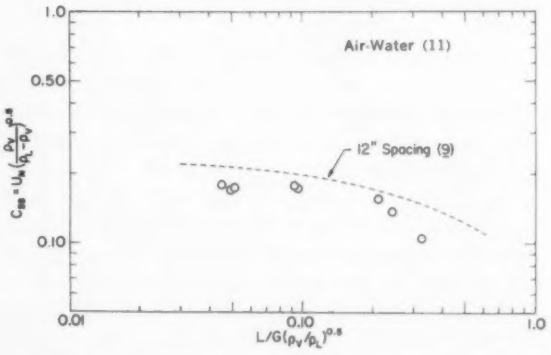

FIG. 3. Sieve tray flooding, 9-in. tray spacing.

velocity term U_N is based on the "net area" of the tray available for liquid disengagement; normally this area is the difference between total area and area blocked off by one downcomer. Unusual baffling effects on the tray can reduce this area.

To develop a sieve tray flooding correlation, it is necessary first to consider bubble-cap tray flooding. In a previous article,[9] the author presented a design chart for estimating entrainment-flooding limits of bubble-cap trays. It has since been found that the chart gives conservative capacity predictions when the liquid surface tension is greater than 20 dynes per cm. As one would expect, surface tension influences droplet coalescence, and the larger droplet sizes at higher surface tension require greater gas velocities for suspension and carryover.

The work of Hunt et al[10] is of value in arriving at a surface tension correction to flooding. These workers obtained the relationship

$$\bar{e} = B\left(\frac{\sigma_W}{\sigma}\right)\left(\frac{U_N}{T - h_f}\right)^n \quad . \quad . \quad . \quad (3)$$

where $h_f = 2.5\ h_L$.

For a given tray spacing and weir height the relative entrainment ratio for two systems is

$$\frac{\bar{e}_1}{\bar{e}_2} = \frac{\sigma_2}{\sigma_1}\left(\frac{U_{N,1}}{U_{N,2}}\right)^n \quad . \quad . \quad . \quad . \quad . \quad (4)$$

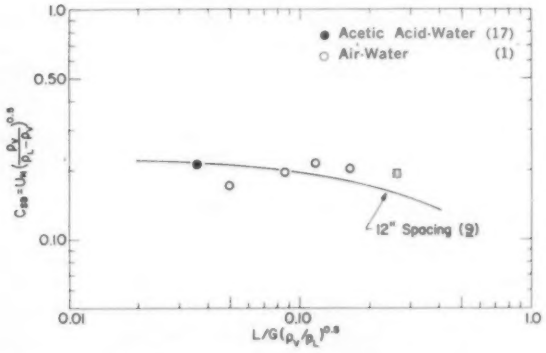

FIG. 4. Sieve tray flooding, 12-in. tray spacing.

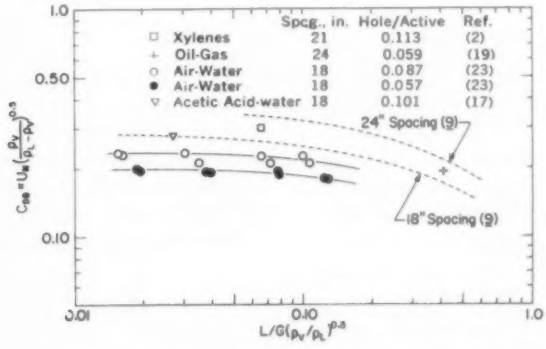

FIG. 5. Sieve tray flooding, 18-24-in. tray spacing.

At flooding, $\bar{e}_1 \sim \bar{e}_2$. Then, Eq. 4 may be rearranged to

$$\frac{(C_{SB})_2}{(C_{SB})_1} = \frac{\phi_2}{\phi_1}\left(\frac{\sigma_2}{\sigma_1}\right)^{1/n} \quad . \quad . \quad . \quad . \quad (5)$$

Accordingly, a surface tension correction would be applied to the C_{SB} values for different systems. Hunt et al obtained a value of $n = 3.5$ for regions of operation removed from the flood point. At incipient flooding, $n \sim 5$ is more reasonable and may be used accordingly.

Fig. 1 shows a plot of flooding data for bubble-cap trays at 24-in. spacing. The curve is taken from the previous paper[9] and the purpose of the plot is to validate the curve for further use with sieve trays. Background and legend are given in Table 1. Capacity factors have been corrected to a basis of 20 dynes per cm surface tension, after Eq. 5:

$$\frac{(C_{SB})\ \sigma = 20}{C_{SB}} = \left(\frac{20}{\sigma}\right)^{0.2} \quad . \quad . \quad . \quad (6)$$

for $\phi_1 = \phi_2$. Since the flow parameter is related both to C_{SB} and ϕ, the condition of constant ϕ means that as C_{SB} is shifted, the flow parameter is shifted also.

$$\frac{(FP)\,\sigma_{=20}}{(FP)} = \left(\frac{\sigma}{20}\right)^{0.2} \quad . \quad . \quad . \quad . \quad (7)$$

Eq. 7 is useful for correlating data, but need not be used for design purposes.

Two conclusions may be drawn from the information in Fig. 1 and Table 1:

1. The curve represents the data well for column diameters of 36-in. and greater. It is conservative for smaller columns, probably because of wall effects in collecting entrained material.

2. A broad range of surface tension is not covered. However, the range of 10 to 30 dynes per cm is typical of most hydrocarbon separations. (Higher surface tensions are dealt with later in the article).

Turning now to sieve tray flooding, one finds that experimental data is largely confined to the lower tray spacings. Fig. 2, 3 and 4 show data for 6, 9 and 12-in. tray spacing, respectively. On each figure is also shown the bubble-cap tray curve for 12-in. spacing. Background details for all tray spacings are given in Table 2. It should be mentioned that all of the work was done with small holes ($< \frac{1}{4}$ in.) and about 10% hole area (referred to plate area between weirs, or "active area"). From Fig. 2 through 4 one may conclude that the bubble-cap tray curve is appropriate though possibly conservative.

Fig. 5 shows data for 18-24-in. tray spacings.

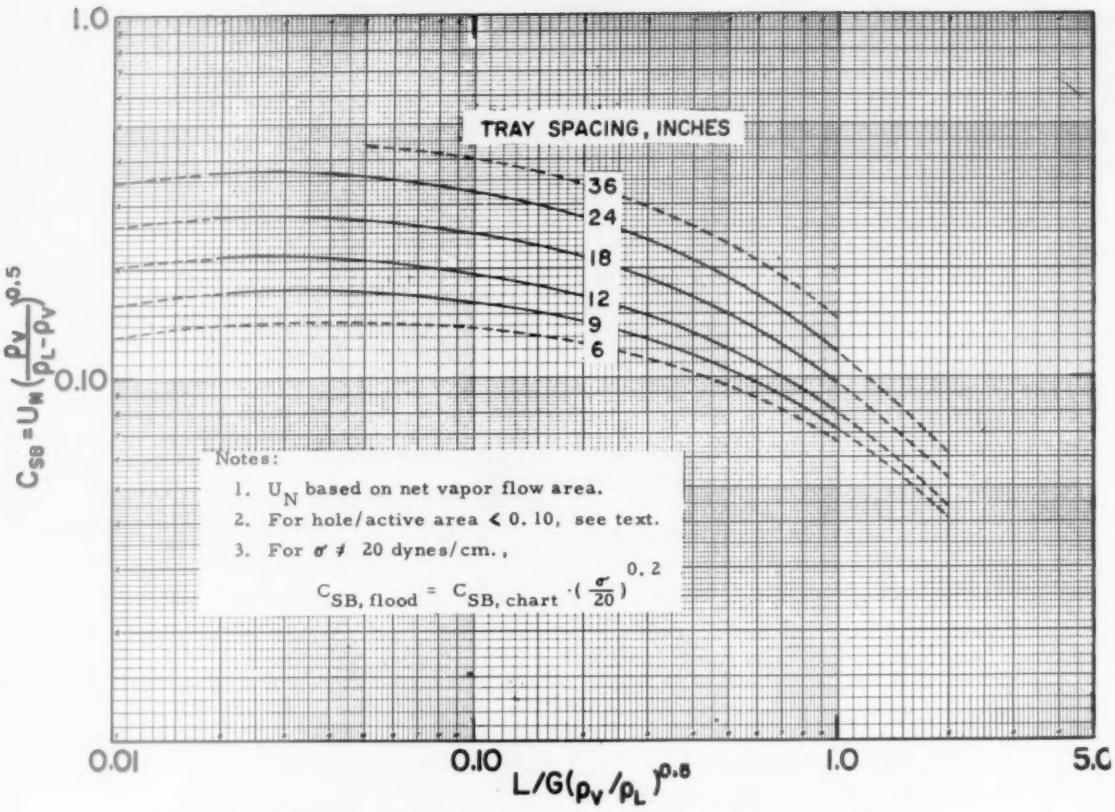

FIG. 6. Flooding capacity, sieve trays (surface tension = 20 dynes per cm).

Mayfield et al[23] used a large simulator with small (3/16-in.) holes and a low ratio of hole area to active area. The capacity of their trays apparently is limited because of low hole area (high hole velocities) and their findings are consistent with those of Friend et al,[11] of Kelley,[18] and of the author in general performance testing. Table 2 expands the information given in Fig. 5.

Again, it may be concluded that the bubble-cap tray curves are appropriate for sieve trays. However, when hole area is significantly less than 10% of the tray active area, the flooding limit should be reduced. In the absence of additional data, the following factors are suggested:

Hole/Active	$C_{SB}/C_{SB, Chart}$
0.10	1.00
0.08	0.90
0.06	0.80

The design chart, Fig. 6, may be used for estimating the entrainment-flood point. The curves are based on the earlier bubble-cap chart[9] plus the foregoing material on sieve trays. The curves show maxima in the vicinity of 0.03 to 0.04 flow parameters; the lower vapor capacity at lower flow parameters is based on observations of "blowing" at high volumetric vapor/liquid ratios plus the measurements of Corlew[7] and Russell[25] in refinery vacuum towers.

Fig. 6 should be used with some caution. The following restrictions should be observed:

- Surface tension is 20 dynes per cm.
- Weir height is less than 15% of tray spacing.
- System is low to non-foaming.
- Holes evenly distributed, and occupying at least 10% of the area between weirs ("active area").
- Hole sizes in the 1/16-¼-in. range.

For low hole areas, the factors previously mentioned may be used. For hole sizes larger than ⅛-in., adequate data is not available. Friend et al[11] show that larger hole sizes increase entrainment, but the specific effect on the flood point is not known.

Fig. 6 is based on commercial towers having diameters of 18-24-in. and larger. For small units, it gives conservative results, as may be

TABLE 2. Studies of Sieve Tray Flooding.

Investigator	System	Tower diameter (in.)	Tower spacing (in.)	Hole diameter (in.)	Percent hole area*	Surface tension (dynes/cm)
Kirschbaum[20]	Ethanol-water	16	5.3	0.099	9.3	20
		30	5.9	0.099	9.3	20
		30	7.9	0.099	9.3	20
Kirschbaum[20]	Benzene-Toluene	16	5.3	0.099	9.3	20
Friend et al[11]	Air-water	(10 x 22)	6, 9, 12	0.188	9.6	73
Jones & Pyle[17]	Acetic acid-water	18	12, 18	0.125	10.1	70
Mayfield[23]	Air-water	78	18	0.188	5.7, 8.7	73
Kelley	Refinery gas absorption	90	24	0.188	5.9	22
—[2]	Xylenes	156	21	0.094	11.3	16

*Referred to active area.

TABLE 3. Studies of Sieve Tray Entrainment.

Symbol (Fig. 8)	Investigator	System	Tray spcg. (in.)	Data points*	FP range	Flood Approach (percent)
○	Friend et al[11]	Air-water	12	15	0.042-0.453	30-92
◐	Friend et al[11]	Air-water	9	22	0.037-0.365	40-90
●	Brook et al[4]	Air-oil	19, 24	15	0.153-0.500	32-69
□	Brook et al[4]	Air-DEG	19, 24	11	0.164-0.397	31-53
△	Jones & Pyle[17]	HAc-water	18	38	0.026	40-95
▽	Jones & Pyle[17]	HAc-water	12	8	0.026	40-95
◇	Kirschbaum[20]	Ethanol-water	6	13	0.0120-0.037	55-90
+	Giles et al[13]	Air-water	12	8	0.089-0.164	46-77

*For $\psi > 0.001$
DEG = Diethylene glycol
HAc = Acetic acid

illustrated by comparing chart values with those of Hunt et al[16] obtained in a 6-in. column at the equivalent of low flow parameters:

Spacing, in.	C_{SB}, Fig. 6 (FP = 0.01)	C_{SB}, Hunt (Corrected)
9	0.160	0.160
12	0.200	0.304
18	0.260	0.375
24	0.340	0.430

Entrainment

The deleterious effect of entrainment in distillation operations is usually related to lowered tray efficiency by means of the Colburn Equation[9]:

$$\frac{E_W}{E_D} = \frac{1}{1 + \frac{e\,E_D}{L_{MD}}} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

The ratio E_W/E_D represents a reduction in efficiency caused by entrainment. It is discussed in some detail by Gerster.[12]

In the previous article[9] a fractional entrainment ψ was defined:

$$\psi = \frac{e}{L_{MD} + e} = \frac{e}{L_M'} \quad . \quad . \quad . \quad (9)$$

by which Eq. 8 becomes

$$\frac{E_W}{E_D} = \frac{1}{1 + E_D\left(\frac{\psi}{1-\psi}\right)} \quad . \quad . \quad . \quad (10)$$

As for bubble-cap trays, fractional entrainment has been correlated with approach to flooding. This "corresponding states" approach is convenient for design purposes, although it places considerable burden upon the correlation of flooding data. In some design cases, the flood point will be known or can be determined in similar equipment. In such cases, approach to flood should be based on experiment.

The final entrainment correlation is presented graphically as the design chart, Fig. 7. Fractional entrainment ψ is plotted against flow parameter FP, with correlating lines of percent flood defined as follows:

$$\text{Percent Flood} = \left[\frac{C_{SB,\,\text{operating}}}{C_{SB,\,\text{flood}}} \times 100\right] L/G = \text{constant}$$

This design chart is used in conjunction with Fig. 6 when both flood point and entrainment must be estimated.

The published data upon which Fig. 7 is based is presented in Table 3. The reliability of the correlation has been checked against all applicable data, with results as shown in Fig. 8.

The scatter in Fig. 8 is inevitable because of the diversity of experimental conditions, sampling and analytical techniques and physical systems. Truly representative measurement of entrainment is difficult indeed, and the relative consistency of the plot could well mean that calculated entrainment values are as good or better than measured ones. In the region of the plot where entrainment significantly influences tray efficiency ($\psi > 0.10$), reliable values are indicated.

Sieve vs Bubble-Cap Trays

The entrainment chart, Fig. 7, points up one interesting fact: At high values of the flow parameter FP, sieve trays can be operated very close to the flood point without significant entrainment. Reference to the previous article[9] will show the same characteristic of bubble-cap trays. Since the flooding limits for the two devices are about the same, sieve trays have little entrainment advantage over bubble-cap trays in the high flow parameter region.

In the low flow parameter region, sieve trays have definite entrainment advantages. This is illustrated in Fig. 9 where fractional entrainment of sieve trays and bubble-cap trays is compared. The conclusion to be drawn from this comparison is that for vacuum-to-moderate pressure service, sieve trays are advantageous. As additional flooding data becomes available,

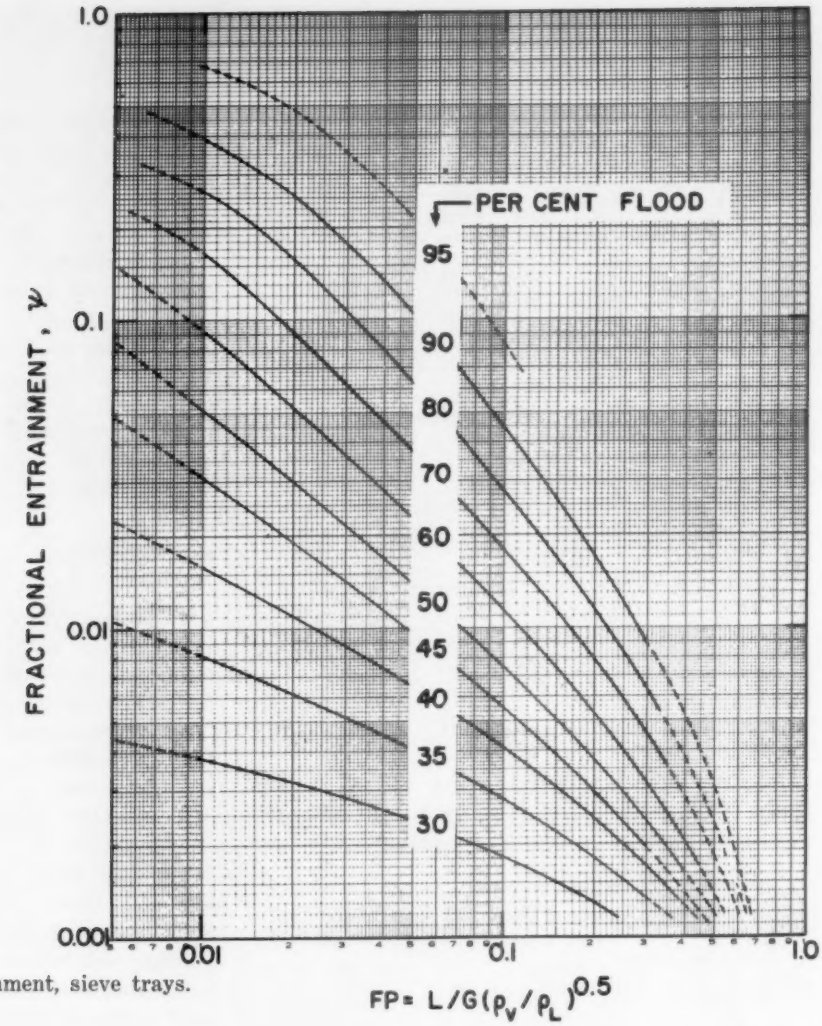

FIG. 7. Fractional entrainment, sieve trays.

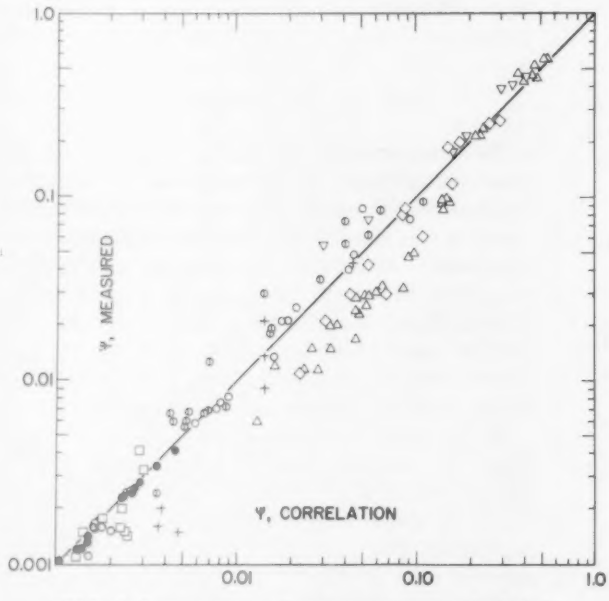

FIG. 8 Comparison of measured and calculated fractional entrainment.

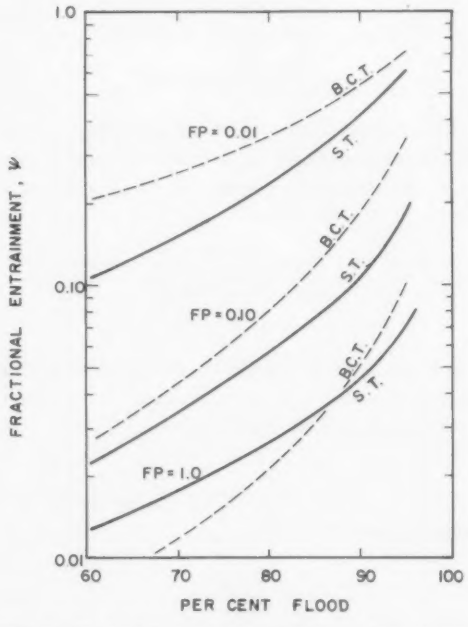

FIG. 9. Entrainment comparison: sieve trays vs bubble-cap trays.

sieve trays may also show greater throughput capacity.

Design Procedure

The design method presented in this paper is best summarized by a stepwise procedure:

1. Establish liquid and vapor flow rates and densities. Obtain or estimate liquid surface tension. If conditions vary significantly across the tower, apply this method to each section of interest wherein conditions can be considered constant.

2. Calculate the flow parameter, FP.

3. Estimate the flood point from Fig. 6. Flooding velocity is obtained from

$$U_{N,\ \text{flood}} = \frac{C_{SB,\ \text{flood}}}{(\rho_V/(\rho_L - \rho_V))^{0.5}}$$

Note that the values taken directly from Fig. 6 apply to sieve trays having a hole area of 10% or more of active area; holes no larger than ¼-in., and liquid surface tension of 20 dynes per cm. Corrections are as follows:

a. Hole area

Hole/Active Area	$C_{SB,\ \text{design}}/C_{SB,\ \text{chart}}$
0.10	1.00
0.08	0.90
0.06	0.80

b. Hole size
No correction for hole diameter $<$ ¼-in. Correction factors for larger diameters not known.

c. Surface tension

$$C_{SB,\ \text{design}} = C_{SB,\ \text{chart}}\left(\frac{\sigma}{20}\right)^{0.2}$$

4. Choose tower diameter which will give the desired approach to flooding. Or, if dealing with an existing tower, calculate the approach to flooding.

5. Estimate the fractional entrainment ψ from Fig. 7.

Example Calculation

For a sieve tray xylene splitter, the following flow conditions are specified:

Liquid rate	200,000 lb per hr
Vapor rate	220,000 lb per hr
Liquid density	46.8 lb per cu ft
Vapor density	0.266 lb per cu ft
Surface tension	16 dynes per cm

From a consideration of contracting requirements, a tower 9.5 ft in diameter is selected. Other pertinent details are: 24-in. tray spacing, 1-in. weir height, 3/16-in. diam holes, 10% hole area (referred to active area) and 8.3 sq ft down-comer area.

The available vapor flow area is $70.8 - 8.3 = 62.5$ sq ft.

Hence,

$$U_N = \frac{220{,}000}{(3600)\ (0.266)\ (62.5)} = 3.68 \text{ ft per sec}$$

$$C_{SB} = 3.68\left[\frac{0.266}{46.8 - 0.27}\right]^{1/6} = 0.278$$

$$\frac{L}{G}\sqrt{\frac{\rho_V}{\rho_L}} = \frac{200{,}000}{220{,}000}\left[\frac{0.266}{46.8}\right]^{1/6} = 0.069$$

From Fig. 6, C_{SB} for flooding is 0.340. This value is for 20 dynes per cm, 10% hole area and small holes. The only correction required is for surface tension:

$$C_{SB,\ \text{flood}} = 0.340\left(\frac{16}{20}\right)^{0.2} = 0.328$$

$$\text{Thus, percent flood} = \frac{0.278}{0.328} \times 100 = 85\%$$

From Fig. 7, $\psi = 0.055$

$$\text{Finally, entrainment} = \frac{0.055}{0.945}\ (200{,}000) = 11{,}600 \text{ lb per hr.}$$

If the dry efficiency at this point in the column is 90%, the wet efficiency is calculated by means of Eq. 10:

$$E_W = \frac{0.90}{1 + 0.90\left(\frac{0.055}{0.945}\right)} = 0.855 = 85.5\%$$

Experimental flooding and entrainment data for sieve trays is not plentiful, and measurements of this are not precise. Accordingly, it has been necessary to relate correlations of flooding and entrainment to those of the well-known device, the bubble-cap tray. It appears that the two devices have about the same flooding limits, so long as usual design practice is followed. However, the sieve tray shows entrainment advantages, especially when used in vacuum and atmospheric service.

Liquid surface tension appears to be an important variable in estimating entrainment and flooding. Many design cases fall into the 20 dynes per cm surface tension range, and correlations are corrected to this value. Column diameter also appears to influence the correlations and small laboratory and pilot plant columns ($<$ 12 in.) are capable of higher loadings than would be estimated from the correlations. Thus, in direct scaleup of small equipment, conservative sizes of commercial equipment are obtained.

Effect of hole diameter on entrainment and flooding appears negligible when the diameter is about ¼-in. or less. The effect of total hole area is to decrease capacity when this area is less than about 10% of the active tray area.

Correlations and design charts are presented to enable rapid estimation of the amount of

entrainment and the approximate flooding limit. The charts are presented as useful and simple design tools and do not attempt to consider all possible variables that can affect entrainment and flooding. Until a better understanding of the complex fluid mechanics of sieve trays is reached, it is doubtful whether a more elaborate correlation can be justified.

Acknowledgment

The author wishes to thank R. L. Matthews for his assistance during the early phases of this work.

Notation

B = Constant in Eq. 3.
C_{SB} = Souders-Brown capacity coefficient, ft/sec.
e = Entrainment rate, lb moles per sec.
$\bar{e}$ = Entrainment rate, lb per lb dry vapor.
E_D = Dry tray efficiency, fractional.
E_W = Wet tray efficiency, fractional.
FP = Flow parameter (Eq. 1), dimensionless.
G = Vapor mass rate, lb per sec or lb per hr.
h_f = Froth height, in.
h_L = Clear liquid height, in.
L = Liquid mass rate, lb per sec or lb per hr.
L_M = Gross liquid molar rate (incl. entrainment), lb moles per sec.
L_{MD} = Liquid molar rate (without entrainment) lb moles per sec.
n = Constant in Eq. 3.
T = Tray spacing, in.
U_N = Vapor linear velocity based on area for de-entrainment (usually tower cross-section minus one downcomer), ft per sec.
ρ_L = Liquid density, lb per cu ft.
ρ_V = Vapor density, lb per cu ft.
σ = Surface tension, dynes per cm.
σ_w = Surface tension of water, dynes per cm.
$\phi = C_{SB}/U_N = (\rho_V/(\rho_L - \rho_V)^{0.5}$.
ψ = Entrainment expressed as fraction of gross down-flow.

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Part 2 — by Dr. J. W. Westwater

Nucleate Pool Boiling

Within the past 10 years many people have responded to the challenge of relating variables for nucleate boiling heat transfer.

Here is a group of correlations of particular interest to design engineers.

These equations do not constitute a complete record, but rather were selected to represent work at scattered locations throughout the world. They are intended to apply to nucleate boiling with no forced convection and no subcooling.

While noteworthy equations were published earlier by Jakob and Linke,[7] Cryder and Gilliland,[8] Cryder and Finalborgo,[9] Insinger and Bliss,[10] Bonilla and Perry[11] and Jakob et al,[12] only progress since 1952 will be treated here.

For discussion purposes, the equations are grouped into two classes, depending on whether surface characteristics of the heat source are considered significant.

Exclusion of a Surface Parameter

One point of view is that the character of the heating surface is of negligible importance (or that there is no way to account for it). Eq. 1 to 8 are of this type.

The expression of McNelly[13] contains five dimensionless groups. The exponents and the coefficient were selected to give a good fit with data for a number of liquids. Note that D and μ_L can be cancelled.

$$\frac{hD}{k_L} = 0.225 \left(\frac{Dq}{\lambda \mu_L}\right)^{0.69} \left(\frac{PD}{\sigma}\right)^{0.31} \left(\frac{\rho_L}{\rho_V} - 1\right)^{0.33} \left(\frac{C_L \mu_L}{k_L}\right)^{0.69} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

(McNelly, 1953)

Sterman[14] presents an argument that the correct dimensionless groups are the ones of Eq. 2:

$$\frac{hD}{k_L} = f\left[\left(\frac{D^3 \rho_L^2 (\rho_L - \rho_V)\, g}{\mu_L^2 \rho_V}\right), \left(\frac{C_L \mu_L}{k_L}\right), \left(\frac{qD \rho_L C_L}{k_L \lambda \rho_V}\right), \left(\frac{\lambda}{C_L T_s}\right)\right] \quad . \quad . \quad . \quad (2)$$

(Sterman, 1953)

Sterman used some of the Cichelli-Bonilla data[15] to discover a functionality satisfying Eq. 1 at the peak heat flux. He obtained the same equation as the well known peak-flux equation of Kutateladze.

The Forster-Zuber equation[16] was developed to describe the peak heat flux and its ΔT. Subsequently it was extended to include q vs ΔT for the rest of the nucleate boiling region. For some systems the equation gives a good prediction; however, it has not received widespread testing.

$$\left(\frac{C_L \rho_L \sqrt{\pi \alpha_L}\, q}{k_L \lambda \rho_V}\right) \left(\frac{2\sigma}{\Delta p}\right)^{1/2} \left(\frac{\rho_L}{\Delta p}\right)^{1/4} = 0.0015 \left[\frac{\rho_L}{\mu_L} \left(\frac{C_L \rho_L \Delta T \sqrt{\pi \alpha_L}}{\lambda \rho_V}\right)^2\right]^{0.62} \left(\frac{C_L \mu_L}{k_L}\right)^{1/3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

(Forster-Zuber, 1955)

Gilmour[17] obtained an empirical equation by arranging the suspected variables to give familiar groups:

$$\left(\frac{h}{C_L G}\right) \left(\frac{C_L \mu_L}{k_L}\right)^{0.6} \left(\frac{\rho_L \sigma}{P^2}\right)^{0.425} = 0.001 \left(\frac{D G}{\mu_L}\right)^{-0.3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Here G is a carefully defined value, representing the supposed velocity of the liquid as it moves toward the heat transfer surface to replace the escaping vapor. Thus $G = (q\rho_L)/(\lambda\rho_V)$. If we substitute for G and also use $h = q/\Delta T$, Eq. 4a which relates q to ΔT is obtained:

$$\left(\frac{\lambda \rho_V}{C_L \rho_L \Delta T}\right) \left(\frac{C_L \mu_L}{k_L}\right)^{0.6} \left(\frac{\rho_L \sigma}{P^2}\right)^{0.425} = 0.001 \left[\frac{D q \rho_L}{\mu_L \lambda \rho_V}\right]^{-0.3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4a)$$

(Gilmour, 1958)

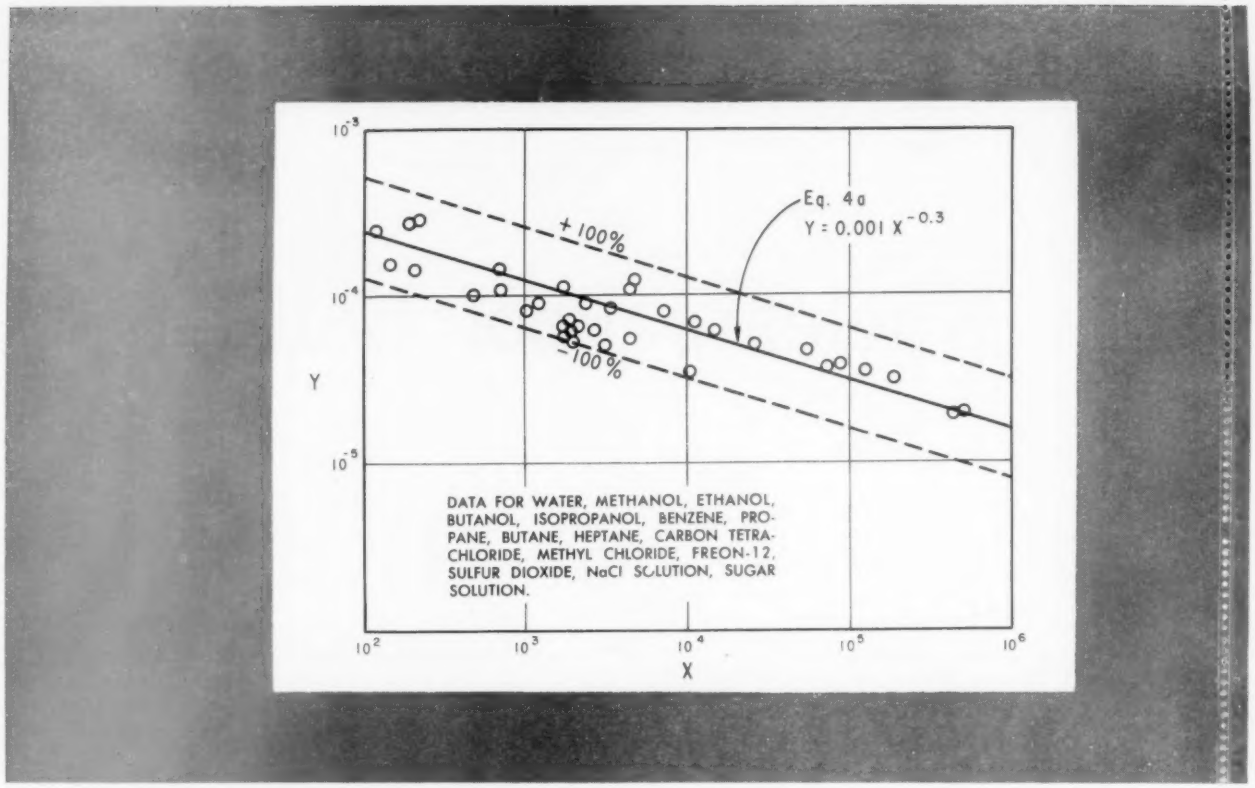
Eq. 4a
Y = 0.001 X^-0.3
+100%
-100%
DATA FOR WATER, METHANOL, ETHANOL, BUTANOL, ISOPROPANOL, BENZENE, PROPANE, BUTANE, HEPTANE, CARBON TETRACHLORIDE, METHYL CHLORIDE, FREON-12, SULFUR DIOXIDE, NaCl SOLUTION, SUGAR SOLUTION.
Y
X

FIG. 3. Correlation of Gilmour.[17] X is the portion enclosed in brackets on the right side of Eq. 4a. Y is the entire left side of Eq. 4a.

Fig. 3 shows Eq. 4a tested with data for 15 liquids from eight papers. No disagreement in the graph is worse than 100%; however, the restrictions stated by Gilmour must be kept in mind. The disagreement increases if data for polished surfaces is included. Also, when discs are used one must include a multiplier with the diameter to obtain the correct significant length, D. Thus for a 7.875-in. disc, D is selected as 4.0 in.

Three of the groups in Eq. 4 and 4a are dimensionless. The pressure group, however, is not dimensionless. It can be made dimensionless by including the factor g/g_c so as to obtain $(\rho_L \sigma g)/(P^2 g_c)$. If this is done the coefficient is dimensionless. Otherwise, the coefficient 0.001 is dimensional and is correct only if the units used are the exact ones which were adopted by Gilmour.

Forster and Greif[18] formulated a model and used dimensional analysis. Published data was utilized to fix the constants. Forster and Greif state that their expression is intended for clean surfaces only. They show that Eq. 5 is adequate for water from 1 to 50 atm and for butanol, aniline and mercury.

Hughmark[1] tested the equation with five additional liquids. Some sizable deviations from Eq. 5 were discovered: 163% for ethanol at 1 atm, 190% for nitrogen at 1 atm, 210% for propane at 170 psia and 450% for propane at 475 psia.

$$q = 1.2 \times 10^{-3} \left(\frac{\alpha_L C_L T_s}{J \lambda \rho_V \sigma^{1/2}}\right) \left(\frac{C_L T_s \alpha_L^{1/2}}{J \lambda^2 \rho_V^2}\right)^{1/4} \left(\frac{\rho_L}{\mu_L}\right)^{5/6} \left(\frac{C_L \mu_L}{k_L}\right)^{1/5} (\Delta p)^2 \quad . \quad . \quad . \quad (5)$$

(Forster and Greif, 1959)

Levy[19] assumed a model whereby bubbles grow in a superheated film of constant temperature. For a given set of operating conditions the ratio of the final size to initial size for all bubbles is assumed to be a constant.

$$q = \frac{k_L C_L \rho_L^2 (\Delta T)^3}{B_L \sigma T_s (\rho_L - \rho_V)} \quad . \quad . \quad . \quad (6)$$

(Levy, 1959)

The dimensionless coefficient B_L is not constant. It is a function of the product $\lambda \rho_V$. Levy presents a graph giving values of $1/B_L$ for various values of $\lambda \rho_V$ and includes a recommended line for subsequent users. In several cases the deviation between this line and actual data is as great as 100%. Levy tested his equation with water, benzene, heptane, ethanol, isopropanol, butanol, propane, carbon tetrachloride and a potassium carbonate solution.

Hughmark tested Levy's equation with addi-

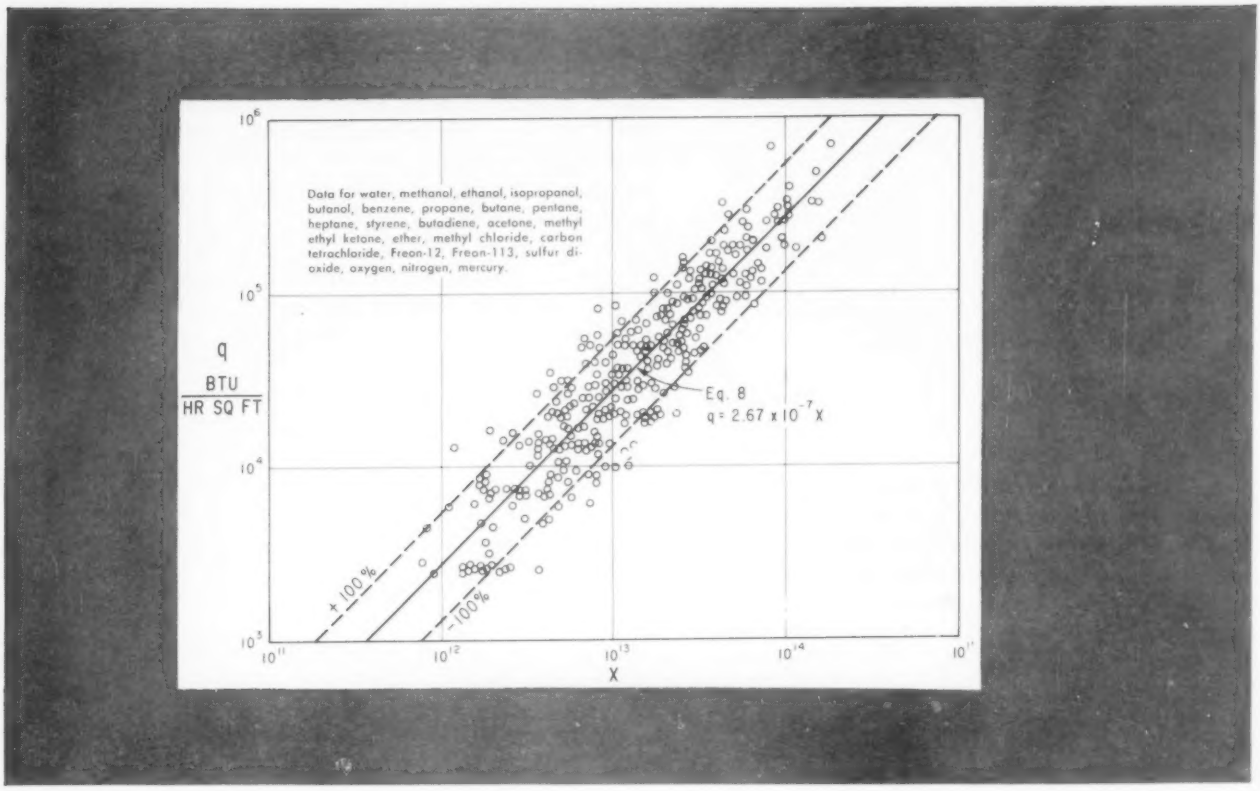
Data for water, methanol, ethanol, isopropanol, butanol, benzene, propane, butane, pentane, heptane, styrene, butadiene, acetone, methyl ethyl ketone, ether, methyl chloride, carbon tetrachloride, Freon-12, Freon-113, sulfur dioxide, oxygen, nitrogen, mercury.
q
BTU
HR SQ FT
Eq. 8
q = 2.67 x 10⁻⁷ X
+100%
-100%
X

FIG. 4. Correlation of Hughmark.[1] X represents the portion in brackets on the right side of Eq. 8.

tional data. He shows that Eq. 6 is reliable within 90% for all cases except propane at 475 psi. For this one case the error is 390%.

Chang and Snyder[20] used dimensional analysis to obtain Eq. 7. An adjustable coefficient is C, but it is not stated to be a function of the heating surface.

$$h = 0.146\, k_L \left\{ 1 + Ch \left[\frac{\Delta p}{C_L\, \mu_L\, k_L\, \sigma} \right]^{1/2} \left[\frac{C_L\, T_S\, (\rho_L - \rho_V)\, \Delta p}{(\lambda\, \rho_V)^2} \right]^{1/6} - \left[\frac{\mu_L{}^2}{\rho_L{}^2\, g\, \beta_L\, \Delta T} \right]^{1/2} \right\}^{2/3} \left\{ \frac{g\, \beta_L\, \Delta T\, \rho_L}{\mu_L\, \alpha_L} \right\}^{1/3} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

(Chang-Snyder, 1960)

They show that Eq. 7 gives a good fit for water at atmospheric pressure. The reliability for other conditions is unknown. At high heat fluxes, Eq. 7 reduces to Eq. 7a:

$$h = \text{const}\, \frac{k_L\, \Delta p^{1.4}\, [C_L\, T_S\, (\rho_L - \rho_V)]^{0.4}}{\sigma\, (\rho_V\, \lambda)^{0.8}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7a)$$

Hughmark[1] made no attempt to set up a model for the mechanism of nucleate boiling heat transfer. He started with the list of 32 variables mentioned earlier which affect the heat flux and then eliminated all but eight of these in order to simplify the job. Then an assumption was made that the remaining variables were related by simple power functions, and a digital computer was used to obtain the best exponents to fit the 23 liquids listed in Fig. 4.

Fig. 4 indicates that Hughmark's result for saturated pool boiling, Eq. 8, is a reasonable expression, but that deviations of more than 100% are common.

$$q = 2.67 \times 10^{-7} \left[\frac{(\Delta p)^{1.867}\, (\rho_L - \rho_V)\ _W{}^{2.27}\, C_{L,W}{}^{0.945}\, T_S{}^{1.618}}{\rho_{V,W}{}^{1.385}\, \lambda_W{}^{1.15}\, \mu_{L,W}{}^{1.630}\, (P/P_C)^{0.202}} \right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

(Hughmark, 1961)

The subscript, $_w$, for the variables indicates they are to be evaluated at the wall surface temperature, T_s, of the heat source.

Inclusion of a Surface Parameter

The point of view that the surface characteristics of the heat source are significant was advanced by Rohsenow et al. Rohsenow's expression, Eq. 9, contains two parameters of interest. The contact angle, β, depends on the liquid and the solid; so does the arbitrary coefficient C_{sf}. The equation has been used widely. Usually the two parameters are combined into

one which is determined empirically. The graphs published by Rohsenow[21] shows that data may deviate from the equation by as much as 100% in some cases.

$$\left(\frac{h\beta}{k_L}\right)\left(\frac{g_C\,\sigma}{g\,(\rho_L-\rho_V)}\right)^{1/2} = \frac{1}{C_{SF}}\left[\left(\frac{\beta q}{\mu_L\,\lambda}\right)\left(\frac{g_C\,\sigma}{g\,(\rho_L-\rho_V)}\right)^{1/2}\right]^{2/3}\left(\frac{C_L\,\mu_L}{k_L}\right)^{-0.7} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

(Rohsenow, 1952)

The exponents 2/3 and −0.7 were chosen to give a good fit to data for water, benzene, ethanol and pentane.

Nishikawa and coworkers have given extensive attention to the development of an equation for nucleate boiling. Their first equation[22] contained the number of bubble-producing sites and also the stirring length for a bubble. Later papers showed how to express these two items in terms of other variables.[23,24,25,26] The final result is Eq. 10:

$$\frac{hD}{k_L} = 8.0\left[(F_S)^{1/2}\left(\frac{P}{P_0}\right)\left(\frac{C_L\,\rho_L{}^2}{M^2\,P\,k_L\sigma\,\lambda\,\rho_V}\right)^{1/2} D^{3/2}\,q\right]^{2/3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

(Nishikawa, et al, 1956)

The factor F_s is called the foamability. It is meant to be descriptive of the nucleation characteristics of the surface. The value of F_s is 1.0 for clean smooth surfaces; it can be as high as 3.6 for rough surfaces. Apparently it was hoped that F_s would depend on the solid only and not on the liquid, and one paper[23] makes such a claim. However, the published values indicate that the physical properties of the liquid do affect F_s, and thus it is similar to Rohsenow's arbitrary constant.

Fig. 5 reproduces Nishikawa's correlation with data for water and seven organic liquids. All this data is for systems having assumed values of $F_s = 1.0$. The heat transfer surfaces include wires, tubes and plates. The pressure covers a wide range. Water, for example, is represented from 15 to 2500 psia.

The correlation appears to be very good in Fig. 5. In only two cases does the data deviate from the equation by as much as 100%.

But, as discussed earlier, appearances may be deceiving when q vs h is graphed. Suppose we choose a ΔT. Then an error in h by a factor of 2 increases the ordinate by a factor of 2. At the same time the abcissa will be increased by a factor of $2^{2/3}$ because it contains q and this is proportional to h. If the erroneous point were plotted on the graph it would be in error along both axes, and its final deviation from the graphed line would show the ordinate as being off by the factor 1.59. The real error would be 100%, whereas Fig. 5 would give an impression that the error was just 59%. If Fig. 5 were replotted to show q vs ΔT, the scatter of data would increase.

Eq. 10 may be misleading from another standpoint. It contains a significant length D, which seems to indicate that nucleate boiling is sensitive to the size of the heating surface. But a closer inspection shows that D can be cancelled. In fact, Eq. 10 may be reduced to Eq. 10a, containing no significant length:

$$q = (\text{const.})\left(\frac{F_S\,P\,C_L\,\rho_L{}^2\,k_L{}^2\,(\Delta T)^3}{\sigma\,\lambda\,\rho_V}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10a)$$

(Nishikawa)

Hughmark tested Eq. 10 with additional liquids not used by Nishikawa. The equation gave predictions for q which were correct within 100% except for two cases. Propane at 475 psia gives an error of 178%, and mercury at atmospheric pressure gave an error of 13,000%. Hughmark's Eq. 8 is off by 13% and 23% for these two cases.

Ruckenstein[27] considers that bubbles form at cavities in the heating surface. These are spaced at random. The final expression is a statement of the necessary dimensionless groups. It contains two arbitrary constants which are intended to represent the surface structure. Let L be a significant length representing the mean distance between active sites, and let l_o be a significant length representing the mean diameter of the sites.

$$\frac{hD_b}{k_L} = f\left[\left(\frac{q\;\rho_L\,D_b}{\lambda\,\rho_V\,\mu_L}\right),\left(\frac{C_L\mu_L}{k_L}\right),\left(\frac{2\,\sigma\,T_L}{l_o\,\lambda\,\rho_V\,\Delta_C}\right),\left(\frac{\Delta T}{\Delta T_C}\right)\right] \quad . \quad . \quad . \quad (11)$$

(Ruckenstein, 1959)

It is assumed that the ΔT_c value is determined by the value of L. Ruckenstein gives no comparison with data, and he gives no numerical values for L or l_o. The significant aspect of the paper is the claim that at least two constants are needed to define the surface.

In 1961 Miyauchi and Yagi[28] published a study which had been presented before the Society of Chemical Engineers, Japan, in 1951. Artificial nucleation sites were drilled in the heating surface, and the functionality between

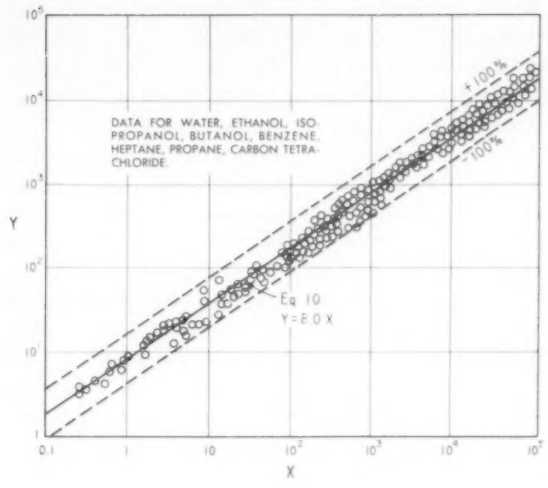

FIG. 5. Correlation of Nishikawa.[23] X is the portion enclosed in brackets on the right side of Eq. 10. Y is the group hD/k_L.

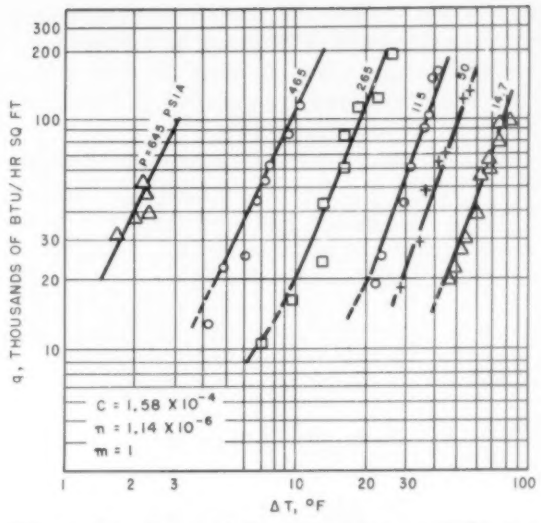

FIG. 6. Chang's correlation,[29] Eq. 13, using the data of Cichelli and Bonilla[15] for benzene. The dashed lines are Eq. 14.

Table 1. Comparison of Nucleate Boiling Equation.

Author	EXPONENT ON ..														
	ΔT	Δ_p	λ	Pv	σ	k_L	P_L	C_L	μ_L	P	P_C	T_S	g	D	P_L-Pv
Hughmark[1]		1.867	-1.15	-1.385				0.945	-1.630	-0.202	0.202	1.618			2.27
McNelly[13]	3.22		-2.22	-1.06	-1	1		2.22		1					1.06
Forster-Zuber[16]	0.24	0.75	-0.24	-0.24	-0.5	0.79	0.49	0.45	-0.29						
Gilmour[17]	3.33		-2.33	-2.33	-1.417	2	0.917	1.333	-1	2.83				-3.33	
Forster-Greif[18]		2	-1.5	-1.5	-0.5	0.79	0.5	0.46	-0.29			1.25			
Levy[19]	3				-1	1	2	1				-1			-1
Chang-Snyder[20]	1	1.4	-0.8	-0.8	-1	1		0.4				0.4			0.4
Rohsenow[21]	3		-2		-0.5	5.1		-2.1	-4.1				0.5		0.5
Nishikawa[23]	3		-1	-1	-1	2	2	1		1					
Miyauchi-Ya gi[28]	3.85		-2.85	-0.19		-2.43	2.85	2.43	-0.42						

h and the number of active sites was determined. For a population of active sites greater than 32 per sq cm. (206 per sq in.) the boiling curves, h vs ΔT, were "normal." The following correlation was obtained for normal curves, at atmospheric pressure. Two of the groups are dimensional.

$$\frac{h}{k} = C_1 \left(\frac{q\,\rho_L}{\lambda\,\rho_V\,\mu_L}\right)^{0.74} \left(\frac{\rho_V}{\rho_o}\right)^{0.69} \left(\frac{C_L\,\mu_L}{k_L}\right)^{0.63} \quad (12)$$

(Miyauchi-Yagi, 1961)

The parameter C_1 also is dimensional. It depends on the liquid used and on the smoothness of the heating surface. Organic liquids on "idealized surfaces" have $C_1 = 1.3$ meter$^{-0.26}$. For other surfaces and for water C_1 varies from 0.7 to 1.9. Miyauchi and Yagi present a graph to demonstrate the good fit of Eq. 12. The data used comes from nine papers and includes 10 liquids. The right side of Eq. 12 ranges through four orders of magnitude. The fit is about as good as that of Nishikawa. The reliability at pressures other than atmospheric is unknown.

Chang[29] stated that the phenomenon of nucleation must be accounted for in any expression for nucleate boiling heat transfer. He uses an expression from Volmer as modified by Eyring. The result is Eq. 13:

$$q = \frac{C_1\,\rho_L\,C_L\,\Delta T\,N_A\,(KT_S)^{3/2}}{H\,\sigma^{1/2}} \cdot e^{-hxy-m} \quad (13)$$

(Chang, vigorous boiling, 1961)

$$\text{where } x = \left(\frac{16\,\pi\,\sigma^3}{3\,K\,T_S\,(\Delta p)^2}\right)$$

$$y = \left(\frac{\rho_L\,C_L\,\Delta T}{\lambda\,\rho_V}\right)$$

Eq. 13 is for vigorous boiling only. The parameters C_1, n and m are arbitrary constants for nucleation. They depend on the liquid, and

the heating surface and must be computed from experimental data. The range of values for m is small; organic liquids seem to give m = 1, while water and mercury give m = 2. The values of C_1 and n vary considerably.

If the boiling is feeble, Chang states that free convection is dominant and Eq. 14 should be used (except for liquid metals). The ratio ε/α_L is selected so as to match Eq. 14 to Eq. 13 at an appropriate value of ΔT:

$$q = 0.145 \frac{k_L}{D} \left(1 + \frac{\varepsilon}{\alpha_L}\right)^{2/3} \Delta T \ (Gr - Pr)^{1/3} \quad . . . . . (14)$$

(Chang, feeble boiling, 1961)

Problem of Surface

Which of the 14 equations is correct? Some of the authors (Hughmark is a good example) used brute-force correlation of variables, ignoring all models and theories. The results are fairly reliable, but deviations in q by factors of two or more do occur with an uncomfortable frequency.

Some of the equations are derived, at least in part, for an assumed model for the mechanism of boiling heat transfer. At present there is no convincing proof that any of the models is correct. A few are admittedly incorrect. Rohsenow's derivation, for example, uses a direct proportionality between q and the number of active sites, whereas recent data[30] shows that a better relation employs the square root of the number of actual sites, at least for well-polished surfaces.

Table 1 shows an interesting comparison of the equations, which are simple power functions. Obviously the theoretical models used by Forster-Zuber, Forster-Greif, Levy, Rohsenow, Nishikawa, Gilmour, and Chang-Snyder are in substantial disagreement. Nucleate boiling equations based on models are prone to errors which also are in the order of a factor of two. In no case can one design safely without using a safety factor of two or more.

Possibly several stumbling blocks are preventing the development of a successful equation for nucleate boiling. The chief obstacle is the problem of the solid surface. Bubbles form only at nucleation sites during nucleate boiling. When the bulk liquid is at its saturation temperature, the rate of heat transfer is equal to the number of active sites multiplied by the rate of phase change per site. The latter value can be computed if one knows the size of the bubbles at break-off and the frequency of bubble generation per site. Active sites are known to be imperfections in the heating surface,[31] primarily microscopic pits and scratches. The number of these is a function of the surface texture; rough surfaces give higher heat fluxes than smooth ones at the same ΔT.

At a given ΔT all pits and scratches are not active. For a site to produce bubbles it must contain some trapped gas and it also must have a size which is larger than the critical size for that ΔT. The critical size is determined by the surface tension and by the vapor pressure relationship for the liquid in question. A first estimate of the critical size is furnished by the Gibbs equation, $\Delta p = 2\sigma/R$, where R is the pit radius, σ is surface tension, and Δp is the vapor pressure difference corresponding to the given ΔT.

Suppose a heat transfer test was made with a surface having many pits, say 1000 per sq in., all containing gas and all of exactly the same diameter, say 0.001 in. At low superheats all of the heat transfer would be by free convection only. But once the specific ΔT for nucleation was exceeded, all the sites would become active, vigorous boiling would occur and suddenly the heat flux would become very great. The boiling curve, q vs ΔT would be almost vertical. None of the present boiling equations predicts such a curve.

Of course, no one has made such a heat transfer surface. But every solid surface that is manufactured does have imperfections, and no two surfaces are alike in respect to the sizes, numbers and spacing of these flaws. It is not reasonable to expect two surfaces to give identical boiling curves.

Each equation for nucleate boiling employs some functionality between q and ΔT. The Rohsenow equation, for example, gives q proportional to $(\Delta T)^3$, Gilmour uses $(\Delta T)^{3.33}$, Miyauchi and Yagi use $(\Delta T)^{3.85}$, Forster and Greif use $(\Delta P)^2$, and so on. Each of these functionalities can be precise for some one special distribution of active sites. But a distribution which will make one equation correct will invalidate the others.

Is there any way out of this dilemma? An analogous situation arose in the field of radiation heat transfer many years ago. After Boltzmann and Planck had derived the fundamental equations, the matter of theory vs real data was considered. Almost no solids obey the theoretical expressions for radiation. A result was the invention of the terms non-black body, gray body and emissivity.

The emissivity is of particular interest. It is an arbitrary constant and must be found by experimentation. Its value depends on the chemical composition of the solid, the surface rough-

ness, and the wave length of the radiation. Designers use tables of emissivities. The values are typical values only, for it is almost impossible to construct two surfaces which will have identical emissivities. The emissivity prevents high accuracy in design.

We may anticipate a similar outcome for boiling heat transfer. Perhaps future handbooks will have tables of "nucleation factors" for various solids. These could be subdivided according to the degree of polish. For a given solid with a given polish, maybe the nucleation factor will be a single constant. If so then a present expression with one undetermined constant, such as that of Rohsenow, Miyauchi and Yagi or Nishikawa, may be adequate. However, two or three numbers may be needed to characterize a surface.

For example, the mean pit size, standard deviation of the pit size, and the total number of sites per unit area are three factors that could describe a "normal" pitted surface.

Perhaps a nucleation factor will be a set of three numbers. Of the nucleate boiling expressions in this article, two use more than one constant. Ruckenstein uses two constants, but his expression is unfinished. Chang[20] uses three constants.

By adjusting his constants, Chang was able to fit his equations to data for water, ethanol, isopropanol, butanol, acetone, benzene, carbon tetrachloride, three terphenyls and mercury. A wide variety of pressures was used. The metals were chromium, copper and platinum, and the shapes included wires, tubes and plates.

Engineers who do curve fitting know that three arbitrary constants permit a better fit than can be obtained with fewer constants. Therefore Chang's equation should give a better fit than the others. Most of his graphs show data scatter well below the 100% encountered by others. Typical are Chang's curves for benzene in Fig. 6.

Safety Factor

Studies of nucleate pool boiling still have far to go. Pool boiling design can be carried out with correlations such as those of Gilmour, Hughmark and others, but a safety factor of 100% or more must be included. Some unreliability results from uncertainty as to what the true variables are. To a greater degree, uncertainty is caused by a lack of knowledge of how to characterize the heating surface. Strong indications exist that two or possibly three constants are needed for this. The equation of Chang and the proposal of Ruckenstein indicate two ways to characterize the surface.

About the Author

Dr. James W. Westwater, professor of chemical engineering at the University of Illinois, Urbana, has published more than 35 technical articles, largely on aspects of boiling heat transfer, and has produced seven high speed motion pictures as part of his research work. He has received three National Science Foundation research grants and also has had grants from the Bureau of Ships and Du Pont. Listed in American Men of Science, Who's Who in Engineering and Who's Who in the Midwest, he is active on a national level in the American Institute of Chemical Engineers and American Chemical Society. He holds a BS in Chemical Engineering from the University of Illinois and MChE and PhD degrees from the University of Delaware.

Nomenclature

B_L = Arbitrary constant in Levy's equation.

C = Arbitrary constant in Chang-Snyder equation.

C_L = Heat capacity of liquid, Btu/lb/F.

C_{SF} = Arbitrary constant in Rohsenow's equation.

C_1 = Arbitrary constant in Chang's equation and in Miyauchi-Yagi's equation.

D = Significant length for heating surface, ft.

D_b = Bubble diameter at break-off, ft.

F_s = Foamability, arbitrary constant in Nishikawa's equation.

g = Acceleration of gravity, ft/hr^2.

g_c = Conversion factor, 4.18×10^8 lb mass – ft/lb force – hr^2.

G = Gilmour's choice of velocity, $(q\rho_L) / (\lambda\rho_v)$.

G_r = Chang's Grashof number for boiling, dimensionless.

h = Boiling individual heat transfer coefficient, Btu/hr/sq ft/F.

H = Planck's universal constant, Btu hr.

J = Conversion factor, 778 ft lb/Btu.

k_L = Liquid thermal conductivity, Btu/hr/ft/F.

K = Boltzmann's universal constant, Btu/molecule/F.

L = Ruckenstein's constant for cavity spacing, ft.

l_o = Ruckenstein's constant for cavity size, ft.

M = Constant in Nishikawa's equation, 900m^{-1}, or 274 ft^{-1}.

m = Arbitrary constant in Chang's equation

n = Arbitrary constant in Chang's equation

N_A = Avagadro's number, molecules / mole.

Pr = Prandtl number for liquid, dimensionless.

P = Ambient pressure on the liquid, lb/sq ft.

P_c = Thermodynamic critical pressure, lb/sq ft.

P_o = Standard pressure, one atmosphere.

Δp = Vapor pressure difference corresponding to ΔT, lb/sq ft.

q = Heat flux, Btu/hr — sq ft.

R = Pit radius, ft.

T_L = Temperature of bulk liquid, F.

T_s = Temperature of heating surface, F.

ΔT = Temperature difference driving force, F.

ΔT_c = Value of ΔT at peak heat flux, F.

x = Defined below Eq. 13, dimensionless.

X = General expression defined in captions for graphs.

y = Defined below Eq. 13, dimensionless.

Y = General expression defined in captions for graphs.

α_L = Thermal diffusivity, $k_L / (\rho_L C_L)$, ft² / hr.

β = Contact angle.

β_L = Liquid coefficient of expansion, 1/F.

ϵ = Chang's eddy diffusivity for boiling heat transfer, ft²/hr.

λ = Latent heat of vaporization, Btu/lb.

μ_L = Liquid viscosity, lb/ft — hr.

ρ_L = Liquid density, lb/cu ft.

ρ_o = Vapor density at atmospheric pressure, lb/cu ft.

ρ_v = Vapor density, lb/cu ft.

σ = Surface tension, lb/ft.

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The introductory part of Dr. Westwater's paper appeared in Petro/Chem Engineer's August issue on Heat Transfer.

■

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Dr. J. M. Marchello

Mathematics Workshop

Calculus / Part 1

THE BASIC OPERATIONS OF CALCULUS are those of integration and differentiation. These two seemingly unconnected limiting processes are intimately related and are in fact inverse to one another, like the operations of multiplication and division, or addition and subtraction.

A. Integration

Perhaps the easiest way to explain the process of integration is in terms of the problem of finding the area under a curve, Fig. 1. Consider the problem of determining the area bounded below by the segment $(a \leqslant x \leqslant b)$ on the x-axis, on the sides by the perpendiculars to the x-axis at the points $x = a$ and $x = b$, and above by the curve $y = f(x)$.

The area under the curve in Fig. 1 can be determined as a limiting process in the following way:

Subdivide the segment $(a \leqslant x \leqslant b)$ into small subintervals and replace each strip of the area under the curve by a rectangle whose height is between the greatest and the smallest height of the curve in that strip. The sum of the areas of these rectangles represents an approximate value for the actual area under the curve.

The approximation of the area becomes better as the number of rectangles chosen becomes larger, so that in the limit of an infinite number of rectangles, each of infinitesimal width, the sum of the rectangular areas equals the exact area as a limit. Accordingly, the definition of the integral is

$$\int_a^b f(x)\,dx = \lim_{n\to\infty} \sum_{i=1}^{n} f(X_i)\,\Delta X_i \quad . \quad . \quad (1)$$

where:

$\int_a^b$ designates the process of integration

from $x = a$ to $x = b$

$\Delta X_i = (b\text{-}a)/n$.

$\sum_{i=1}^{n}$ designates the process of summation over the n rectangles.

$f(X_i)\,\Delta X_i$ is the area of rectangle i.

Lim $_{n\to\infty}$ represents the limiting process of n passing to infinity.

dx indicates that x is the variable of integration.

Another fundamental operation which serves to illustrate the nature of integration is that of finding the mean or average value of a function. In Fig. 1, the mean value of f (x) over the interval $(a \leqslant x \leqslant b)$ is given by the expression

$$y_m = \frac{1}{(b\text{-}a)} \int_a^b f(x)\,dx \quad . \quad . \quad (2)$$

Combining Equations 1 and 2 yields an equation for the mean value in terms of a limiting process

$$y_m = \frac{1}{(b\text{-}a)} \lim_{n\to\infty} \sum_{i=1}^{n} f(X_i)\,\Delta X_i \quad . \quad (3)$$

Thus it is often said that integration has the effect of averaging or smoothing a function.

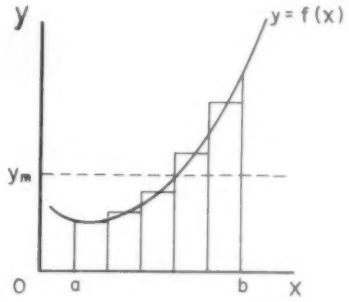

FIG. 1. Area approximation.

PROBLEM 11

Dimerization of Butadiene

In a pilot plant study of the dimerization of butadiene the change of total pressure, π, was measured as the reaction proceeded. The experiments were carried out in a constant volume autoclave held at constant temperature.

To use the constant volume data in the design of continuous flow reactors it is necessary to determine the constants in the rate equation:

$$-\frac{dp}{d\theta} = kp^n \quad . \quad . \quad . \quad (11\text{-}1)$$

where: k is the reaction rate constant

n is the order of the reaction

$p = 2\pi - \pi_o$ is the partial pressure of butadiene

At a temperature of 550F the following data were obtained. Assuming a second order reaction determine the value of the reaction rate constant.

time θ, min	Pressure p, psia
0	25.0
5	22.0
10	19.0
20	15.5
30	13.2
50	10.0
70	8.5
90	6.8

Solution: Assuming that the dimerization of butadiene can be described as a second order reaction, the rate equation becomes

$$-\frac{dp}{d\theta} = k\,p^2 \quad . \quad . \quad . \quad (11\text{-}2)$$

Rearranging and integrating,

$$\int_{p_o}^{p} \frac{dp}{p^2} = -\int_{o}^{\theta} k\,d\theta \quad . \quad . \quad (11\text{-}3)$$

Since k is a constant the right hand side of Eq. 11-3 becomes $-k\theta$. While the left hand side of Eq. 11-3 could be handled graphically, it is more convenient to use the standard form

$$\int v^n dv = \frac{v^{n+1}}{n+1} + C \quad , n \neq -1$$

Applying this rule, where $n = -2$,

$$\int_{p_o}^{p} \frac{dp}{p^2} = \left[\frac{p^{-2+1}}{-2+1}\right]_{p_o}^{p} = -\frac{1}{p} + \frac{1}{p_o}$$

The initial partial pressure of butadiene was equal to the total pressure, $p_o = \pi_o$.

The final integrated form of Eq. 11-3 becomes:

$$\frac{1}{p} - \frac{1}{\pi_o} = k\theta \quad . \quad . \quad (11\text{-}4)$$

Eq. 11-4 shows that a plot of $1/p$ versus θ should be a straight line with a slope equal to k, the reaction rate constant. The data are plotted in this fashion in Fig. 2. The fact that

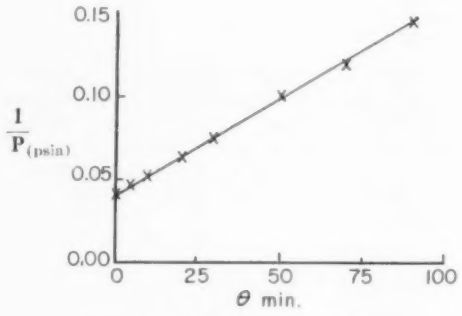

FIG. 2. Dimerization rate data.

the data fall on a straight line indicates that the assumption of a second order reaction was correct. The slope of a line through the data is

$$k = 0.00116 \text{ (psia)}^{-1} \text{ (min)}^{-1}$$

This value of the rate constant was obtained by merely drawing a best line through the data. From a statistical standpoint the value of k should be calculated by fitting the data to Eq. 11-4 by the method of least squares discussed earlier.

PROBLEM 12

Linear Lag Control System

A certain piece of equipment in a pneumatic control system is thought to have the properties of linear lag. In other words, if the input pressure is raised from zero to P_1 by a step change at the start, $\theta = 0$, the output pressure P_2 rises from its initial value of zero according to the equation

$$T\frac{dP_2}{d\theta} + P_2 = P_1 \quad . \quad . \quad (12\text{-}1)$$

where the coefficient T is the time constant of the equipment.

What method of plotting the response data would you recommend in order to establish quickly the existence of a linear lag and the value of its time constant?

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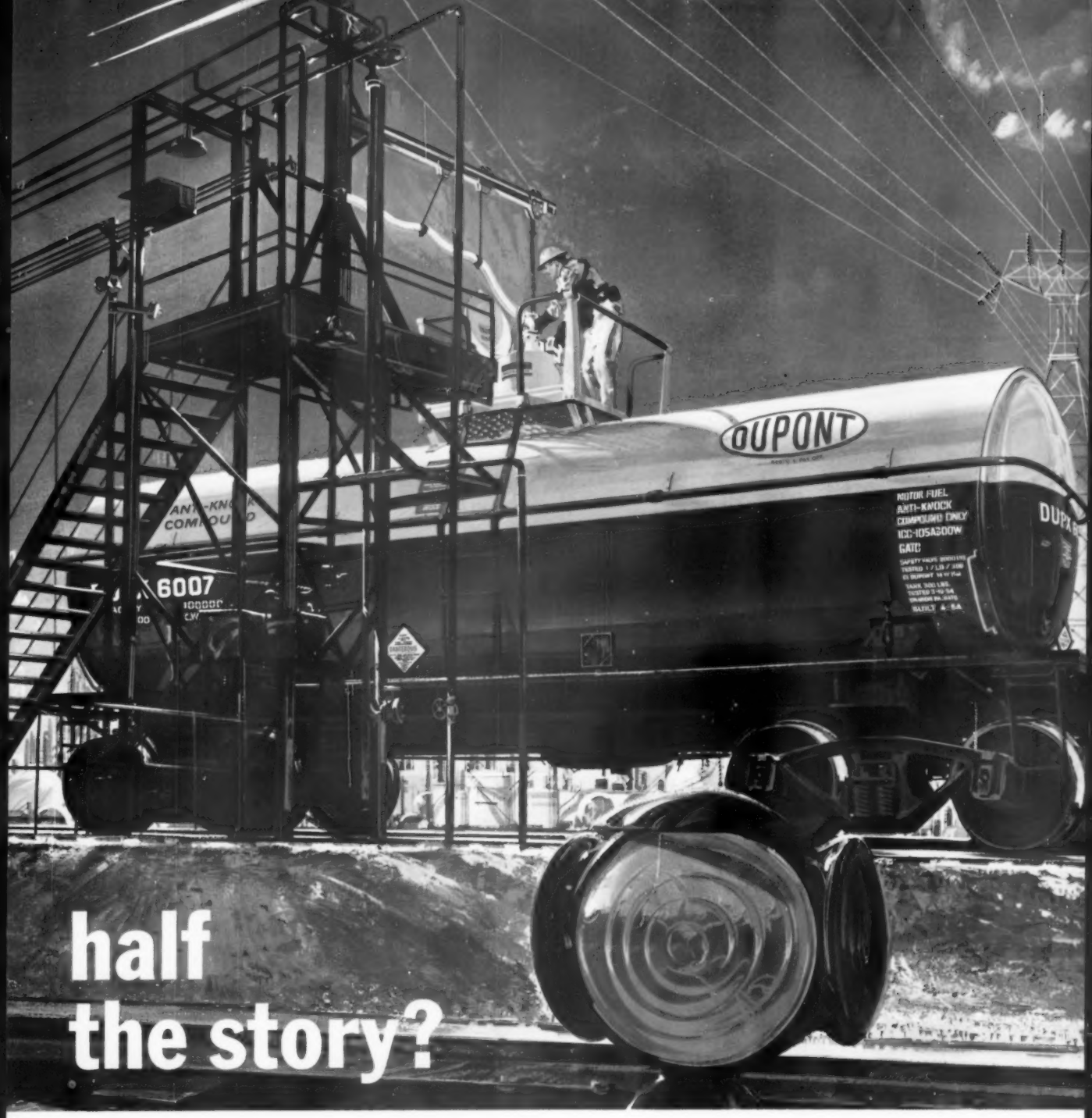

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By Dr. O. K. Crosser

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1. Houston, Texas	Jet Fuel Kerosine	6,000 to 10,000	0.007 to 0.035	3–6'x20'	0.5	1.0 to 2.0	6 NaOH 0.8 PbO	4	4.5 years 0.5	20	2–4	—	130°	None
2. E. Chicago, Indiana	No. 1 Fuel Kerosine	4,500	0.007 to 0.01	3–6'x10'	1.0	1.6	10 NaOH 1.3 PbO	6	No Rework For 3 yrs. 0.25	10	1–3	—	130°–140°	Water Wash Only
3. E. Chicago, Indiana	No. 1 Fuel Kerosine	4,500	0.007 to 0.01	4–3'–6"x10'	1.0	1.6	10 NaOH 1.3 PbO	6	No Rework For 11 yrs. 0.20	10	1–3	—	130°–140°	Water Wash Only
4. Marcus Hook, Pa.	Kerosine	7,600 to 14,000	0.007 to 0.01	4–6'x25'	0.05	1.7	5–7 NaOH 0.7 PbO	4	28 months cat. life 0.70	15	4–6	0	130°	Clay Contact
5. Beaumont, Texas	Kerosine	20,000 to 25,000	0.015 to 0.09	3–10'x24'	0.35 to 1.9	1.25 to 2.0	5–25 NaOH	4–8	27 months cat. life 0.8	30	5–20	0–3	130°	Petreco Water Wash
6. Long Beach, Calif.	P.D. Gasoline	1,200 Charge 3,600 Recycle	0.045 to 0.09	2–4'–8"x18'	1.0 to 1.7	1.2 to 1.4	18 NaOH 0.5 PbO	6	26 months cat. life 0.65	16	10–20	0	85°–90°	None
7. Norwalk, Calif.	S.R. Gasoline	4,000	0.006	2–5'x22'	1.0	1.0	2–10 NaOH	4	Reworked After 18 mos. 0.5	20	2–5	0	85°–105°	None
8. Norwalk, Calif.	Jet Fuel P.D. Gasoline	2,500	0.007 to 0.02	2–4'x22'	0.2 to 1.0	1.0 to 2.0	2–10 NaOH	4	No Rework for 3 yrs. 0.5	20	2–5	0	85°–110°	Acid Treat Jet Fuel None on P.D.
9. Linden, N. J.	S.R. Gasoline	1,200	0.0016 to 0.002	3–3'x16'	0.05	1.0	2–10 NaOH	3	No Rework for 20 mos. 0.5	30	1–3	0	85°–100°	Water Wash Only
10. Bronte, Ont.	No. 1 Fuel	3,420	0.005	2–5'x20'	0.3	1.8	2–10 NaOH	6	No Rework for 18 mos. 0.5	30	1–3	0	120°–130°	Petreco Water Wash
11. Odessa, Tex.	Jet Fuel	1,111 to 1,700	0.002	2–30"x22'	0.2	1.5	3 NaOH	3	No Rework for 18 mos. 0.5	30	1–5	0	110°–120°	None
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13. Calgary, Canada	No. 2 Fuel	1,600 Recycle 1,600	0.069	2–4'x18'	2.0 to 3.0	1.5	20 NaOH	3	No Rework for 18 mos. 0.5	20	2–5	0	130°–160°	Water Wash Only

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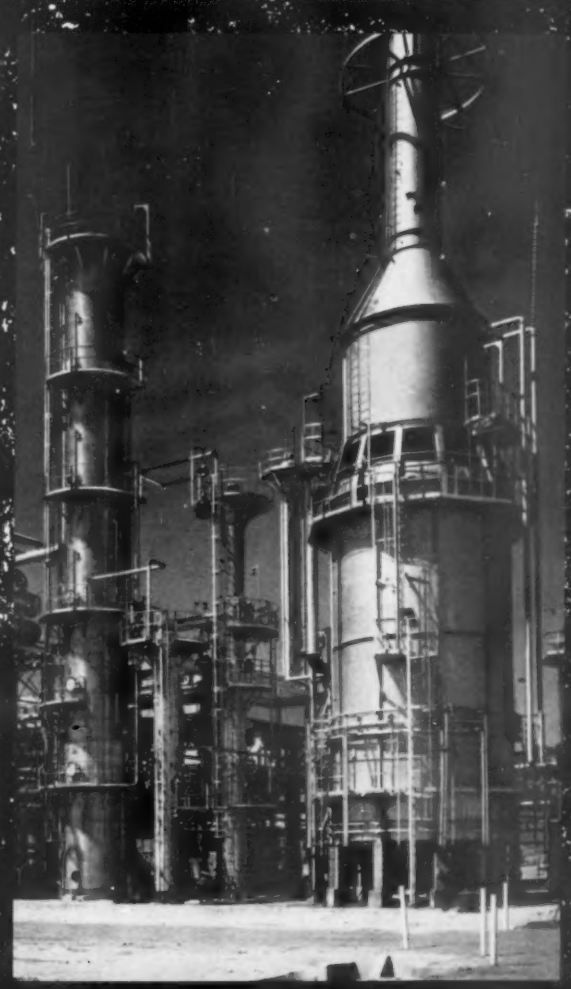

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A 62-page list describes symposiums, manuals, special publications, indexes, compilation of standards, charts, reference photographs and reports published by American Society for Testing Materials. *American Society for Testing Materials.*

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All About Gasket Materials

New 24-page gasket materials brochure details resistance rating for 120 fluids and gases. Technical data charts appear with description of Garlock's 25 standard rubber styles, 8 styles of cloth-inserted rubber sheet for gasketing service, 14 styles of cloth-inserted rubber sheet for diaphragm service, 9 styles of compressed asbestos sheet, 4 styles of woven asbestos and 5 styles of vegetable fiber sheet. *Garlock Inc.*

Circle number (42) on reply card.

Additives Described

Aliphatic organic chemicals as additives for gasoline, fuel oil, lubricants and asphalt are subject of new booklet. *Armour Industrial Chemical Co.*

Circle number (43) on reply card.

Automatic Shutoff Valves

New IP-L/TEMP valves provide dual automatic safety by closing on either increasing pressure or ambient temperature or both. A diaphragm senses line pressure and programs valve into closed position whenever line pressure exceeds a pre-determined level. Also, a fusible plug with pre-determined temperature setting is activated whenever ambient thermal point is reached. *Security Valve Co.*

Circle number (44) on reply card.

Bellows Seal Valves

With Series 473 bellows seal valves, control and complete isolation of rare and dangerous fluids at extreme temperatures and pressures can be handled simply and with maximum safety. Valves have forged stainless steel bodies with inert arc-welded bellows assemblies. High pressure version is rated for operation at 2000 psi and for tempera-

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SAMPLE BOMBS

Circle Seal leak-proof, bubble-tight check valves and shut-off valves assure that a valuable sample will not be lost because of valve leakage.

Valve bodies are 303 stainless steel, with O-ring seals of various materials. Other body materials available on order. Pressures as high as 6000 PSI. Write us about your application, stating type of fluid and maximum pressure of sample.

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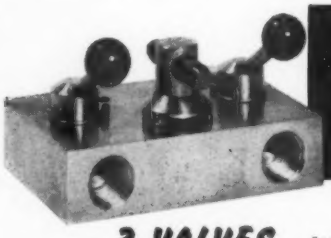

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Reduces installation costs.
Available in brass or 303 stainless.

Specifically designed for use with differential type measuring, recording or transmitting instruments in refinery, petrochemical plants, pilot plants, test labs and research labs.

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The P-727 does not require valve seat replacements and no operating adjustments are necessary.

One variation provides a bleed hole to vent both instrument ports when balancing valve is open. Another variation replaces basic five valve assembly.

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precision valves

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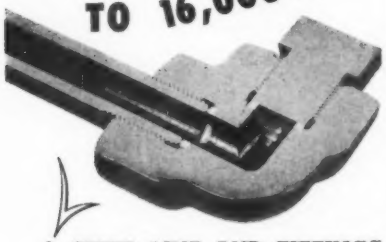
PRESSURES TO 16,000 PSI



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Leak-proof Fitting Seal

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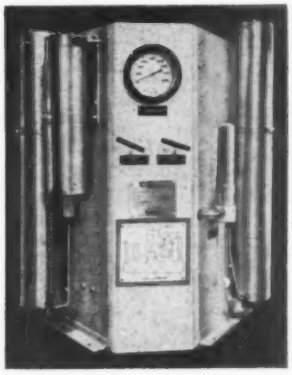

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3429-D OCEAN VIEW BLVD.
GLENDALE 8, CALIFORNIA

tures to 600 F. Lower pressure version is rated at 400 psi and for service to 350 F and has replaceable teflon seats and gaskets. Every valve is helium leak-tested in production, with maximum allowable leakage of only 0.0005 micron cu ft/hr. *Hoke Incorporated.*

Circle number (45) on reply card.

Blower-Nozzle Bulletin

Steam jet blowers and blast nozzles are discussed in a new product bulletin. Dimensions, weights and capacities are given for all sizes. *Schutte and Koerting Co.*

Circle number (46) on reply card.

Boiler-Pressure Vessel Chart

Handy wall chart "Quick Reference Guide to ASME Boiler and Pressure Vessel Code (Section VIII)" shows types of pressure vessel construction provided for under this section and furnishes direct references to the Code rules that apply. *Missouri Boiler and Tank Co.*

Circle number (47) on reply card.

Chromatograph Materials

Column packing materials for gas chromatography are listed, along with price, in issue of "Chromatofacts." Included are 37 stationary liquid phases, five inert solid supporting materials in various mesh ranges, 10 active solid adsorbents in different mesh ranges and over 200 combinations of coated solids ready for immediate packing into columns. *Research Specialties Co.*

Circle number (48) on reply card.

Chromatograph Sampling Valve

New valve is designed especially for measuring off and taking samples for analysis by gas chromatography. It will fit into most fluid analysis systems, whether chromatographic or otherwise, where samples of liquids or gases must be analyzed for chemical content. Port connections are for unflared ⅛-in. tubing, with O-ring compression seal. Maximum working pressure for gases is 50 psi; for liquids, 90 psi. Temperature range is from –65 to +250 F. *Republic Manufacturing Co.*

Circle number (49) on reply card.

Closer Mesh Grating

Load-bearing capacity has been increased 60% through use of 36 bars in each standard 2-ft width in a new closer mesh grating. Clear opening is ½ in. Also available in

. . . one of a series presented by Western Supply Company, Tulsa, to improve the "I.Q."* of engineers . . .
(*"Income Quotient")

TRAINED SPECIALISTS VITALLY IMPORTANT IN PROCESS ENGINEERING AND ESTIMATING . . .

The rapid, even meteoric development of the petro-chemical industry in the past decade has enhanced the role of importance played by engineering specialists with each step of its progress. Today, the engineer who is equipped with knowledge, study, training and experience in some specific phase of the processing cycle finds himself in an extremely favorable position and nowhere is this more obvious than in the realm of process engineering and estimating.

But industry has a new concept of a "specialist" in the complex of today's business society. He must have a broad concept of the total effort of his company, and cannot be content simply with "doing his job better than anyone else can." Since companies today, large or small, see their profits shrink as costs increase, the engineering specialist must apply his special knowledge or skill to the task at hand with diligence and genius, but with a practiced eye on the effect of his specialty on the profit structure of his company (or his client, or customer, if he is a consultant or supplier).

A generation ago, the "all-round" process engineer was himself a specialist, experimenting, researching, studying developing—combining "educated guessing" with engineering judgment to solve the problems presented. His was the task of dealing with all phases of an engineering process — design, estimating, operating — material and heat balances, temperatures, pressures, flow quantities, the design of special equipment, specification of instruments and controls, stress analysis, corrosion control, etc., etc.

Today, with larger, more complex plants — especially in continuous flow processes — and with greater expense involved in more complicated processes, many specialties have grown from the earlier process engineer specialist, resulting in accelerated advances in each specific field, as demands for more rapid progress are met. The petro-chemical industry in particular has demanded, attracted, developed — and paid for — men of unusual ability and broad vision, expert in their specific fields, communicative, articulate, aware and appreciative of the problems of other specialists as well as of business in general — and therefore more "profitably productive" for their companies. The search for these men increases with each new demand on the industry.

What training, background, experience is needed by today's process engineer to become a specialist? What is required in addition to an extraordinary interest and aptitude for a specific phase of engineering? There are certain technological requirements related to each field, of course, and they are fairly well-defined in each phase, but there are other more general, yet equally important, qualities and attributes on which the aspiring specialist must pass muster.

Space limitations in this column do not, of course, permit a full treatment of this important subject, it is covered more completely and in greater detail in our Booklet E-5, "Trained Specialists," and complimentary copies are available to you by writing to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. BOX 1888, TULSA, OKLA. —and remember, our engineers specialize in designing, estimating and building the heat exchangers in your future.

For more than 35 years Koch Engineering Company has served industry. Adherence to the highest mark of quality has resulted in the build-up of a top-flight engineering staff. Their skills — combined with the latest facilities for design, development, and testing — originated today's most economical fractionating tray: *the Koch Flexitray*. Their experience — gained through years of leadership in research and practice — is your assurance of the *continued* quality of this low-cost . . . widely imitated tray.

In specifying fractionating devices for your next tower installation — remember: the *quality* of Koch Flexitray can *not* be imitated!

See our catalog in "Refinery Catalog" — or contact your nearest Koch Representative.

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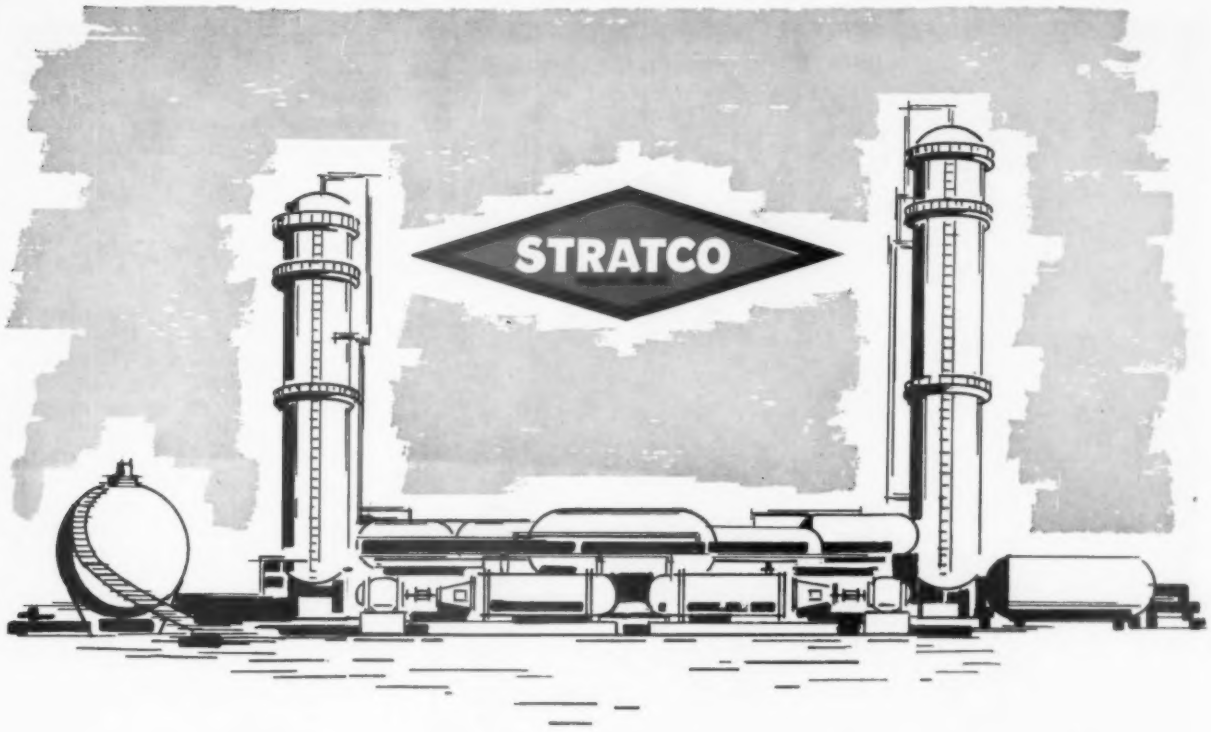

Effluent Refrigeration Chosen for World's Largest Alkylation Unit

At its Texas City, Texas plant, American Oil Company has contracted for the installation of the largest single alkylation unit in the world. The plant will use the Stratco system of effluent refrigerated alkylation to process a mixture of propylene and butylene olefins. Design capacity is approximately 15,000 barrels of crude alkylate per day. The total alkylate will be used as a high octane blending component in motor fuel, without debutanizing or rerunning.

Stratco's extensive alkylation experience in the design of this type plant is available to refiners without charge. Through the use of electronic computation various design cases can be quickly screened and optimum arrangements can be developed.

Specific inquiries are cordially invited.

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BIG IN THE RUBBER PICTURE

The simple one-step HOUDRY DEHYDROGENATION PROCESS produces butadiene for synthetic rubber throughout the world. In addition, it can produce butene. Other mon- and diolefins may also be produced from the corresponding saturated hydrocarbons.

Capacity placed on stream in the U.S. since World War II is capable of producing very close to 50 per cent of the butadiene required by the domestic synthetic rubber industry. The HOUDRY DEHYDROGENATION PROCESS is also on stream in plants in Italy, West Germany, and Japan. Write for a full description.

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37 bars in each 2-ft wide panel (⅜-in. opening between bearing bars) and in other, minimum bar sizes. Grating maintains a high degree of visibility and ventilation and is easy to maintain. *Blaw-Knox Co.*

Circle number (50) on reply card.

Corrosion Tubing Catalog

Newly published catalog is first widely distributed compilation of data covering the physical and mechanical properties, installation procedures, supply data and corrosion-resisting performance of virtually every type of solid metallic and solid plastic as well as coated and lined tubular product now on the market or about to be marketed. Data was obtained from questionnaires sent to more than 1000 U. S. manufacturers and processors of corrosion-resistant pipe and tubing. *M. L. Sheldon & Co.*

Circle number (51) on reply card.

Coupling Catalogs Offered

New bulletins give specifications on two most popular designs of Snap-Tite quick connect/disconnect couplings. The "E" design is used in high pressure, gravity flow and vacuum systems; "H" model is used primarily in hydraulic lines. *Snap-Tite, Inc.*

Circle number (52) on reply card.

Couplings Feature Novel Seal

A novel all-metal seal is included in new series of cryogenic and high temperature couplings. Unique action of seal will maintain an absolutely tight joint for extremes of temperature shock, pressure surge and vibration. Seals are reusable and reversible. Available in aluminum, stainless steel and other materials to accommodate various fluids at pressure levels from –425 to +1800 F. Sizes range from ¼ in. through 3 in. tube diameter in JT14 series. *Gamah Corp.*

Circle number (53) on reply card.

Double Volute Design

Types DS and DL pumps, featuring double volute design in all sizes, are single-stage, double-suction centrifugal units. Type DS, with provisions for water-cooled packing boxes and bearings, comes in 22 sizes with capacity to 13,000 gpm. Type DL, air cooled, is available in 13 sizes with capacity to 6000 gpm. Bulletin 143 gives specifications, size selection chart. *Pacific Pumps, Inc.*

Circle number (54) on reply card.

Eighty Pages on Alcohols

New 80-page booklet contains comprehensive data on properties and uses of 21 industrial alcohols, from methanol to trideconol. *Union Carbide Chemicals Co.*

Circle number (55) on reply card.

Electronic Air Cleaner

Type HVSC Electro-Cell air filter, new self-contained high velocity electrostatic precipitator, is for use in inaccessible areas and with air handling units. Available in 24 sizes ranging from 1000 to 25,000 cfm. Product Bulletin 258B gives specifications. *American Air Filter Co., Inc.*

Circle number (56) on reply card.

Eliminate Refining Hazards

"Safe Handling of Light Ends," latest in American Oil's series of booklets on hazards of refining operations, deals with safe methods for processing, storing and loading hydrocarbons having a Reid vapor pressure of 18 psi or more. 50¢ plus postage. *American Oil Co.*

Circle number (57) on reply card.

Fintubes, Coils Described

All principal types of Brown fintubes and coils are illustrated and described in Bulletin 900. Included are fintube engineering standards covering materials, size, surface area, number of fins and efficiency factors available with various fintubes. *Brown Fintube Co.*

Circle number (58) on reply card.

"Fire-Seal" Valve Seats

"Fire-Seal seats, which provide tight shutoff of flammable or dangerous liquids in event of fire which might elevate temperatures beyond the limits of standard nonmetallic seating materials, are now available in Hills-McCanna ball valves. Valves have primary seat of metal-encaged reinforced teflon which incorporates a secondary metallic seating surface. If teflon is destroyed by excessive heat, shut-off of flow is insured by the metal-to-metal contact between ball and secondary seat. *Hills-McCanna Co.*

Circle number (59) on reply card.

Flexible Ball Joints

Specifying information on flexible ball joints for handling liquid oxygen, liquid methane and other cold temperature liquids and exotic fuels is contained in a 4-page catalog. Joints can handle fluid or gaseous petrochemicals and liquefied petroleum gases and hydrocarbons at temperatures from −325 to +275 F. They permit 360-deg rotary swivel motion and ±10-deg gimbal flexing motion from centerline. Standard sizes are 2, 3, 4. 6, 8, 10 and 12 in., with welding or flanged ends, for operating pressures to 200 psi. *Aircraft Div. Barco Mfg. Co.*

Circle number (60) on reply card.

Flow-DP Transmitters

The 212T series of Transcope flow and differential pressure transmitters features ability to extract square root in flow measurement by simple calibration and large scale indication. Units provide standard 3 to 15 psi output and are available in either indicating or blind form, with transmission accuracy of 0.5% over a continuously adjustable range interval of 20 to 250 in. of water (differential pressure). *Taylor Instrument Co.*

Circle number (61) on reply card.

Have You "MODERNIZED" Your PACKINGS?

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Experienced engineers and purchasing agents long ago discovered "you get exactly what you pay for" when buying gas generation equipment.

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LACK OF DEPENDABLE SERVICE can cost thousands of dollars in downtime. Gas Atmospheres builds the finest generators made today and, to protect our customers, we maintain the industry's largest service engineering staff.

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Remember, Gas Atmospheres is the nation's foremost exclusive manufacturer of gas generation equipment. We do not build for price, but for quality. In the long run this pays off for everyone concerned. *Gas Atmospheres, Inc., 3855 West 150th Street, Cleveland 11, Ohio.*

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Dollar-Saving Data Given

How to provide low cost temperature and distillation rate control with self-operated regulators is diagrammed and described in six application guides. *Spence Engineering Co.*

Circle number (62) on reply card.

High Vacuum Calculator

New sliderule-type high vacuum calculator makes it easy to determine pump or chamber size as well as time and pressure for high vacuum systems. The 8½ by 11-in. calculator consists of two heavy gage

"SCOT" FORGED SEAMLESS RING GASKETS

MINIMUM HARDNESS

Ask for "SCOT" Gaskets at your Supply Store.

For ring Groove Flanges forged from reforging billets in the following materials in stock: Soft Iron, Copper, Aluminum, Inconel, Monel, Nickel; 1¼ Cr ½ Mo., 2¼ Cr 1 Mo., 9 Cr 1 Mo. 304, 310, 316, 321, 347, 405, 410, 430, 502, 304L, 316L, Nickel L, Kel F, Teflon.

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3 — Worthington 3500 CFM air compressors, 24 x 15, Model #LTC-4, 500 HP gas engine drive.

1 — Chicago-Pneumatic 3060 CFM air comp., 60 PSI, #19-32-30-18x24, steam driven.

20 — 28,000 gal. horiz. steel tanks, 11′ x 38′ ASME 75 PSI WP.

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POplar 3-3505

slides held in place by a rigid vinyl casing. Either slide can be used to solve numerous simple vacuum problems. Together they can solve many complex high vacuum problems. $2. *Consolidated Vacuum Corp*

Circle number (63) on reply card.

High Volume Check Valves

Check valves for high volume gas flow provide protection from system surge, backflow and other problems in HPI applications. Operating characteristics include rapid, quiet response with efficient straight-through flow and low pressure drop. Offered in pipe sizes from 6 to 48 in. for pressures to 1000 psi. Available with cast iron, cast steel or alloy steel bodies. *Clark Bros. Co.*

Circle number (64) on reply card.

Lighted Pushbutton Unit

Explosion-proof (NEMA 7) lighted pushbutton station, developed for use in hazardous areas, is intended for heavy duty Class 1, Ground D service. New unit is completely weatherproof and may be used as either a push-to-test pilot light or as a combination pushbutton and pilot light. Designed for use at 110, 220 or 440 v. Standard contact block arrangements are 1-NO, 1-NC, or 1-NO and 1-NC. *Nelson Electric Manufacturing Co.*

Circle number (65) on reply card.

Lubricant for Gas Engines

"The Story of Estor G" tells about Humble's new premium oil specifically developed for gas engines. *Humble Oil & Refining Co.*

Circle number (66) on reply card.

Metal-Sheathed Thermocouples

Trinox metal-sheathed thermocouples are designed for applications involving miniaturization, multi-point sensing and hard-to-get-at points. Wide choice of thermocouple wires permit temperature ranges to 2100 F, and to 3200 F utilizing noble metals. Available in six sizes ranging from 5/16 in. to 0.040 in. OD. *Trinity Equipment Corp.*

Circle number (67) on reply card.

Moves Corrosive Slurries

Model 150-7 Kemlon pump, a diaphragm-type unit, handles corrosive slurries at pressures up to 3000 psi. Barrier diaphragm separates all working parts from fluid handled. Pump employs actuating fluid between piston and diaphragm with-

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Knowing that the "slip stick" is not too far removed from the ancient abacus we have added a new dimension: electronic computation. Now in a fraction of the former time, and far more accurately, we can alternate all of the normal variables to develop the optimum cooler for your requirements. The combination of cooling "know how" and accurate automated engineering is just one more of the advancements that keeps Happy ahead.

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HAPPY

out mechanical linkage of any kind. Standard simplex model has 5-hp explosive-proof motor, capacities from 1½ to 6 gpm. *Keystone Engineering Co.*

Circle number (68) on reply card.

New Sizes of Repair Clamp

Patchmaster heavy duty pipe repair clamps are now available in a wide range of sizes from ½ in. to 24 in. in standard pipe sizes and from 2 through 8 in. in OD pipe sizes. They can be supplied in four clamp widths from 3 through 12 in. *Marman Div., Aeroquip Corp.*

Circle number (69) on reply card.

Photoelectric Tape Reader

Complete specifications on Model PTR-71 photoelectric tape reader are given in new data sheet. Unit incorporates a unique bidirectional drive, with application of chopped reflected light in tape reading process. *Omnitronics, Inc.*

Circle number (70) on reply card.

Process Refractometer

New process differential refractometer makes possible control of liquid process streams based on very small changes in refractive index of stream compared to a sealed or flowing reference standard. Unique flowing reference cell enables accurate blending of two streams even though one varies in composition. Refractometer can measure full scale changes in refractive index as small as 0.00005 with a stability better than 1% of full scale in 24 hours. Instrument's sensitivity is 0.5% of full scale, or 0.00000025 RI. *Waters Associates.*

Circle number (71) on reply card.

Fire Protection Inspection

Chapter 20 on inspection for fire protection, part of the API's Guide for Inspection of Refinery Equipment, is now available at $1 per copy. *American Petroleum Institute.*

Circle number (72) on reply card.

Regulating, Relief Valves

Specifications for some 40 self-contained regulating and relief valves, including several for cryogenic applications, are given in new catalog. *A. W. Cash Co.*

Circle number (73) on reply card.

Removes +40-Micron Solids

New 300-deg DSM wet screening unit will remove all particles down to 40 microns from production streams. While operating characteristics vary with material being handled, a unit occupying only 9 cu ft can handle 500 gpm in a typical application. Rental units are available for pilot or semi-works testing on specific applications. *Dorr-Oliver Incorporated.*

Circle number (74) on reply card.

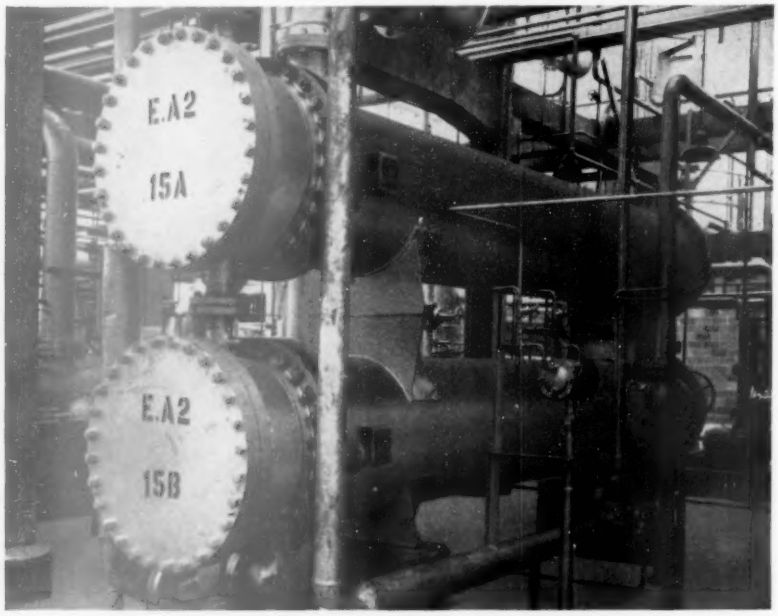
Should You Be an Executive?

A big question faces the working engineer who aspires to greater things. Should he move into management where the rewards seem greatest, or should he remain in the narrower confines of his profession where he can continue to use his technical skills to a greater extent? Booklet E-9, "Engineering-Management Status: Dream or Mirage?", will help you make this decision. *Western Supply Co.*

Circle number (75) on reply card.

Steel Resistance to Hydrogen

Translation of a comprehensive German article deals with resistance of steels to hydrogen at high pressures in the process industries. Authored by Immanuel Class, it is based to a large extent on information developed at the Material Testing Laboratories of Badische Anilin und Sodafabrik, Ludwigshafen, and



EFCO Engineering Efficiency Gives JEFFERSON Most Economical Selection

Jefferson Chemical Company, Inc., is one among many process equipment users who profit from the economy provided by EFCO engineering efficiency. Years of experience in engineering and fabricating heat exchangers for the wide temperature/pressure ranges characteristic of ethylene and other manufacturing processes enable EFCO to offer service-proved engineering design and guaranteed job-ratings. Recognized specialists in handling all grades of carbon, alloy and stainless steels, and nickel, aluminum, and special low-temperature materials, EFCO provides technical service before, during and after installation.

EFCO'S FOUR POINT PROGRAM PROVIDES:

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- technical service before, during and after installation

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includes considerable data on many German steels heretofore virtually unknown in the United States. *Climax Molybdenum Co.*

Circle number (76) on reply card.

Unit in Stainless Steel

Recently introduced super booster model hydraulic jet cleaning unit is now available in Type 304 stainless steel for use where corrosion resistance is required. Other alloys may be specified on order. Units operate on ordinary steam and cold water, delivering hot water at a discharge pressure four to 20 times the input steam pressure. Stream velocity is estimated at 600 ft/sec. *Sellers Injector Corp.*

Circle number (77) on reply card.

Using Reinforced Plastics

Design considerations for applying reinforced plastic materials of construction to corrosive service in process industries are reviewed in reprint of article by Fred W. Arndt of Heil Process Equipment Corp. *William T. Scott, Atlas Powder Co.*

Circle number (78) on reply card.

Centrifugal Process Pumps

End suction centrifugal pumps for process applications can pump liquids ranging in temperature from sub-zero to 350 F at pressures up to 250 lb. Offered in two sub-classes, Series 350 and 300, pumps are manufactured in 14 sizes, ranging from 1 to 5 in., in each series. Series 350 pumps are in stainless steels and other corrosion-resistant materials, while Series 300 units come in iron alloys and bronzes for general process services. *C. H. Wheeler Manufacturing Co.*

Circle number (79) on reply card.

Low-Cost Chemical Pump

Highly efficient, low-cost chemical pump is described in new brochure. *Pacific Perforating Co., Inc.*

Circle number (80) on reply card.

Chem-Petro Directory

Chem-Petro Guide to Canada and Latin America gives name, street address, ownership, affiliated firms, plants and products of the 500 leading chemical and petroleum firms in Canada and 18 countries of Latin America. $12. *Noyes Development Corp.*

Circle number (125) on reply card.

Electric Substation

Power-zone package unit substation, which combines compact size and easy handling with capacities from 75 to 500 three-phase kva, primary voltages up to 4800 v and secondary voltages up to 600 v, is subject of Bulletin SD-137. *Square D Co.*

Circle number (126) on reply card.

Construction Handbook

Construction data handbook — 118 pages containing more than 48 useful construction tables, guides and time-saving charts along with a brief outline of the use, application, and coverage of over 100 Horn construction and maintenance specialties is now available to anyone engaged in building construction or responsible for building maintenance. *A. C. Horn Co. of Texas, Division of Sun Chemical Corp.*

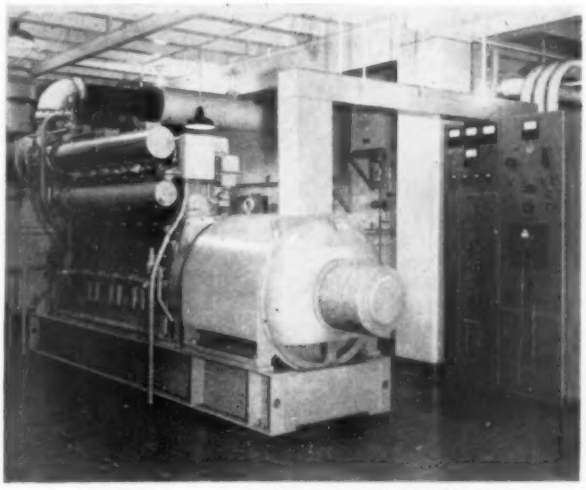
Circle number (127) on reply card.

Fit Pump to Need

Pumping power to fit the need is theme of new 20-page brochure covering all lines of U.S. pump motors and drives, indexed so that they may be identified as to construction type (solid shaft, hollow shaft, submersible

best reasons in the world why it's

IDEAL *



Typical high speed unit with control.

* IDEAL high-speed generators and control equipment pictured above are typical of installations in hundreds of America's leading industrial plants, public utilities and commercial buildings. Custom-designed for longer life with proven efficiency and economy, IDEAL equipment is backed by over a half-century of creative electrical engineering and careful, conscientious workmanship. Unified responsibility for generating units and controls assures you of *better* products *better built* for dependable service with lower operating and maintenance costs. Why not check with IDEAL on your next power application problem?

Write for bulletin 505

The IDEAL ELECTRIC AND MANUFACTURING COMPANY
613 East First Street Mansfield 5, Ohio
MOTORS, GENERATORS AND CONTROLS TO 10,000 H.P.

horizontal, etc.); enclosure (weather protected, drip-proof totally enclosed, explosion-proof, sealed and weatherproof); thrust (high, medium, normal), and U.S. type designation. *U.S. Electrical Motors, Inc.*

Circle number (128) on reply card.

Chempump Bulletin

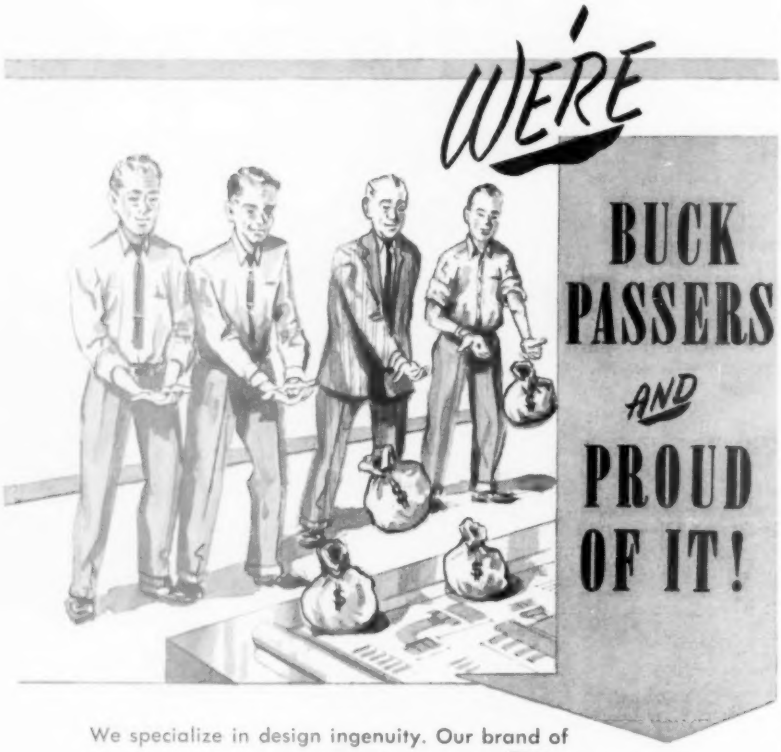
Group CF Chempumps — sealless, centrifugal pumps designed for trouble-free, leak-proof pumping of corrosive, toxic, explosive, radioactive and other problem fluids over a wide range of temperatures and pressures — are treated in Bulletin 1051-1. Design features, performance curves, other specification data are included. *Chempump Division, Fostoria Corp.*

Circle number (129) on reply card.

Oil-Immersed Starter

Oil-immersed medium-voltage Limitamp starter has oil-blast contactor rated 50,000 kva interrupting capacity and a highly protective interlocking system to permit increased applications in semi-hazardous locations. Can be applied on systems of up to 250,000 kva available. Will control up to 1500 hp at 2300 v and up to 3000 hp at 4160 v. *General Electric Co.*

Circle number (130) on reply card.



We specialize in design ingenuity. Our brand of ingenuity is in the custom design (and fabri ation) of heat transfer equipment that does the best possible job for the least amount of money and saves you equipment "bucks." Write for illustrated brochure, personnel data sheet and customer references; let us quote your next job. We'll show you how we can pass bucks back over the table.

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Gate, Globe, Check Valves

Valve catalog contains illustrations, condensed descriptions and specifications on R-P&C bronze, iron body and cast steel gate, globe and angle, and check valves; bar stock valves, and forged steel gate valves. *R-P&C Valve Division, American Chain & Cable Co., Inc.*

Circle number (131) on reply card.

Heat Exchanger Data

C-500 heat exchanger series, featuring removable bundles with floating clamp-ring design, is described in illustrated technical bulletin. These exchangers are fabricated from standard pre-engineered components combined into custom-built assemblies with 19 shell sizes from 6 in. through 42 in. and in any practical tube length. *American-Standard Industrial Division, American Radiator & Standard Sanitary Corp.*

Circle number (132) on reply card.

Non-Corrosive Welding Wire

Iron-free aluminum bronze arc welding wire and filler rod, designated AMPCO-TRODE 7, has been developed specifically for overlay applications. Suggested for use where high hardness is not required, it meets AWS-ASTM Classification E Cu Al A-1. Material is available in bare 36-in. lengths for use with the inert gas, tungsten-arc welding process and in bare spooled wire for use with the inert-gas, metal-arc process. Has excellent resistance to salt water and other forms of corrosion. *Ampco Metal, Inc.*

Circle number (133) on reply card.

New Valve Design

Basic design change in corrosion-resistant globe, angle and "Y" valves for HPI applications promises to give closer throttling control and eliminate disc vibration and chatter. Key features are non-rotating stem with non-rising handwheel and fixed disc. Handwheel and yoke bushing assembly rotate. Available initially in 150-lb types in 2-in. sizes and larger. *Alloy Steel Products Co.*

Circle number (134) on reply card.

Halochem Products Detailed

Standard shapes, custom parts and application engineering services from new Halochem products plant near Dallas are described in brochure that covers rod, tubing and sheet as well as custom molded, extruded or machined parts of Teflon and other halogenated thermoplastics for use in HPI. *Tube Turns Plastics, Inc.*

Circle number (135) on reply card.

Heating season ahead

Time to stabilize and improve your heating oils with FOA-2

No filter clogging. No nozzle plugging. No sludge.

These are qualities you can add to your heating oils, and at low cost, too. Result: a clean, hot, steady-burning fuel that wins added friends for your brand product.

You need only a few pounds of Du Pont Fuel Oil Additive No. 2—usually 5 to 15 pounds per 1,000 barrels—to do the job. This concentration has stabilized millions of barrels of heating and fuel oils since the introduction of Du Pont FOA-2 nine years ago.

FOA-2 solubilizes and disperses. Prevents sludge formation. Dissolves sludge which may already have formed. Reduces insoluble residue to such small particles that they flow and burn right along with the oil. *It stabilizes your product.*

Of course, FOA-2 is ashless—burns completely with the fuel, leaves no traces to foul the burner nozzle.

28 pages of facts. Our 28-page bulletin, "Du Pont FOA-2 for Diesel, Heating, Residual Fuels," contains full details on chemical, physical and performance characteristics. Ask your Du Pont Petroleum Chemicals representative for a copy, or write: E. I. du Pont de Nemours & Co. (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.

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VAN-AIR DRYER Model 12500—typical of large capacity Dryers being used in various types of plants

COMPRESSED AIR DRYERS

can TRIPLE the LIFE of PNEUMATIC EQUIPMENT

By extracting water-vapor, potent acids and micronic particles from air system, VAN-AIR Dryers prevent corrosion, contamination and abrasion of pneumatic equipment. Removing these hidden by-products of air compression (not captured in aftercooler, receiver or drain filter) adds untold hours to the life of air equipment, while it also stops air lines from freezing—even in sub-zero temperatures indoors, outdoors, in plant or yard.

Van-Air DRYER

The VAN-AIR Dryer is unique. NEVER needs regeneration. NEVER requires heat or power. NEVER causes volume loss or carry-over. Delivers air clean, sterile, non-toxic, non-corrosive and DRY (to zero° F. dewpoint). Can be installed outdoors. Operates at LOW cost of

LESS THAN 1-CENT PER 18,000 CU. FT.

PATS. PEND.

Built in wide range of thirty sizes (and multiples) the VAN-AIR can treat ANY volume of compressor output from total air for largest plant to minimal air for smallest device. There is NO LIMIT. Smaller sizes are rated for instruments, spraying, automatic machines, mobile units, brake systems, etc.

PLANT ENGINEERS — Look into the DOLLAR economy and PENNY cost of Van-conditioned compressed air. Ask for brochure on "Moisture Control."

VAN PRODUCTS CO. ★ Engineers ★ Manufacturers

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How to Read Business Papers

Booklet entitled "Why, When and How to Read Business Publications" tells how to develop efficient reading habits so you can extract maximum personal profit from the business press. *Fred Wittner Co., Inc.*

Circle number (136) on reply card.

Chemonitor Described

Hagan Chemonitor, instrument that conducts continuous onstream analyses of critical constituents in water, is subject of new product bulletin. Any colorimetric determination made in the laboratory can be made continuously with this instrument. *Hagan Chemicals & Controls, Inc.*

Circle number (137) on reply card.

Glass Properties Summarized

Expanded data on corrosion resistance and thermal expansion of 32 commercial glasses is given in newly revised brochure, "Properties of Selected Commercial Glasses." It has sections on mechanical, electrical and optical properties; thermal stress; heat transmission, and viscosity of the glasses. *Corning Glass Works.*

Circle number (138) on reply card.

Recommended Lighting

Revised section on recommended levels of illumination, from official Lighting Handbook of Illuminating Engineering Society, may be obtained at 20¢ per copy. *Illuminating Engineering Society.*

Circle number (139) on reply card.

WINSTON "Rigibilt" INSTRUMENT BOXES and METER HOUSES

Extremely rugged and weather-tight, "Rigibilt" Instrument Boxes are fabricated of 18 gauge galvanized steel with bolted, interlocking joints and zinc-coated hardware. Base plate of 3/16" steel has pipe sleeve welded to center hole for stand pipe instrument support. Furnished completely assembled. Available with insulation and steam heating coils.

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Repeat purchases —the best endorsement for Polyken

1956 INSTALLATION, Chester to Bellwood, Va., 4.5 miles of 6" pipe

1960 INSTALLATION, Boswell's Tavern to Gum Spring, Va., 26.7 miles of 18" pipe

Commonwealth Natural Gas makes repeated use of Polyken® tape on strength of past performance

Officials of Commonwealth Natural Gas Corporation of Richmond, Va., were impressed in 1956 with the many advantages of Polyken protection. With confidence based on the cathodic protection needs of their Polyken tape-coated 1956 Bellwood line (*inset photo*), they put this coating to work two years later on their Chester to Petersburg, Va., line (12 miles of 18" pipe). In 1959, *more* Polyken coating . . . Waverly to Ivor, Va., (15.8 miles of 12" pipe). And most recently, the line from Boswell's Tavern to Gum Spring (*main illus.*).

It stands to reason that repeated use is founded on first-hand satisfaction and trust. Many discriminating companies make Polyken protection their standard specification because of its dependable performance. Get full details on Polyken performance and economy from your representative, or write Polyken Sales Division, 309 West Jackson Boulevard, Chicago 6, Illinois.

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now... stop corrosion in LPG pipelines with Unicor LHS®

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A film-forming additive, Unicor LHS preferentially wets all metallic surfaces it contacts forming a protective shield. Its detergency action keeps troublesome deposits from forming.

Highly corrosive salt brine from underground storage of C_3 and C_4 hydrocarbons causes extensive damage to pipelines and adds contaminants to the products as well. Unicor LHS protects both equipment and product from this salt-brine corrosion as well as corrosion from oxygen and water in above-ground storage. Wherever light hydrocarbon products are stored, transported or used, Unicor LHS protects against corrosion... keeps equipment free of deposits.

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WHERE RESEARCH TODAY MEANS PROGRESS TOMORROW

UNICOR LHS

Shaping the Future

PIPE TESTS RESUMED

Field tests of line pipe have been resumed at Athens, Ohio, by Battelle Memorial Institute. The research program, of which this is a part, is sponsored by the American Gas Assn. and leading transmission and distribution companies. Underlying purpose is to determine what causes fractures and how they behave. Better steels already have resulted and still greater progress is expected. The program dates back to 1953 and also includes laboratory research.

PIPE CODE CHANGE

The API Central Committee on Pipe Line Transportation has recommended that non-destructive testing requirements for longitudinal welds be included in API Standard 5L and API Standard 5LX.

FUEL CELL PROGRAM

An educational program on how to build a fuel cell is being conducted by Esso Research and Engineering Co., Linden, N. J. Illustrated instructions have been distributed to some 20,000 high school science teachers through the National Science Teachers Assn. The fuel cell, which runs on methyl alcohol, can be assembled for less than $10.

POLYETHYLENE PIPE

High density polyethylene pipe will be a "standard" installation for gas-gathering lines within five years, Phillips Petroleum Co. predicts. Phillips has more than 2,000,000 ft of the pipe in use for this service, some of it for as long as six years.

LIGHT BEAM SURVEYS

Surveying right-of-way by means of light beam is a new construction aid for pipeliners. An instrument known as the Geodimeter projects a light beam to a distant reflector. The reflector returns the beam to the projecting equipment where it is converted to electrical impulses and time intervals for distance computations. Its most efficient use is at night when there is a minimum of outside light. Pacific Gas and Electric Co. used the equipment recently to map a route between Morro Bay and Kettleman Hills, Calif.

Are your costs too HIGH?

These pipeliners are cutting costs—using SIE control systems

DISPATCHERS CONSOLE used by Cherokee Pipe Line Company for automatic control of liquid line.

SIEMARC Supervisory Systems provide automatic monitoring and remote control for many industrial operations and processes including the petroleum installation pictured. Measuring, data gathering, telemetering, logging, display, indicating and computing are all integrated in the system. Both solid-state and relay components are used as dictated by proper engineering design. Transistors and semiconductor diodes are utilized in all high-speed switching and logic circuits including encoders, decoders, analog-to-digital converters, deviation detectors and magnetic drum circuitry. Separate electric logging typewriters record data and alarms.

POWER LEVEL CONTROLLER used by Shell Pipe Line Corp. Ozark System for maximum pumping station operating economy.

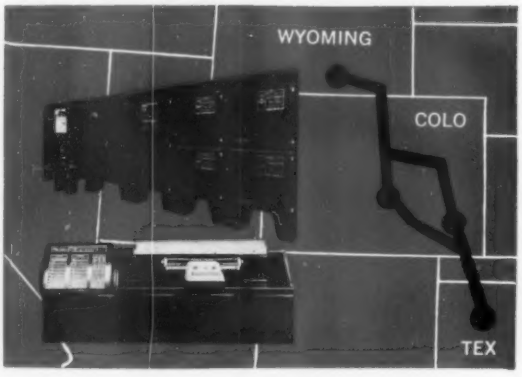
Completely unattended operation of a multi-unit pumping station is possible with Power Level Controllers used by Shell Pipe Line Corp. The unit accepts signals from flow and pressure pickups and makes logic decisions to bring proper combinations of pump units on or off stream automatically. It may be connected to the supervisory control system to permit reset of power levels from a central office dispatching console.

COMPRESSOR STATION CONTROL CONSOLE including complete engine control equipment for automatic station operation and safety.

For gas transmission automation, the basic SIEMARC system can be coupled with Log-Alarm Shutdown and Engine Control-Sequence units. Building block design throughout allows SIE to fit your needs exactly.

DISPATCH PANEL used by Colorado Interstate Gas Company.

In the Colorado Interstate Gas Company installation shown, dispatchers transmit only desired discharge pressure settings; automation at each compressor station responds by maintaining the selected value for optimum station economy. If communication links fail, local automation operates without interruption. Log-Alarm units insure station safety. Dispatchers are alerted only when trouble occurs.



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SIE **DIVISION** ONE OF THE DRESSER INDUSTRIES

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The first volume in a series on how SIE handles supervisory control and automation for the petroleum industry is now available. The booklet gives the ABC's of land line codes, binary techniques — and many more of the basics. A letter brings you "The ABC's of Industrial Telemetering."

ADIS

Communications breakthrough

New Teletype Automatic Data Interchange System (ADIS) now enables the Federal Aviation Agency to interchange aviation weather data coast-to-coast ten times faster than ever before.

With this new electronic message switching system, the FAA effects a major advance in the speed, scope and flexibility of its weather communication service—which supports all civil and extensive military aviation in the United States.

Nucleus of the system is a series of five Interchange Centers, located in Kansas City, Cleveland, Atlanta, Fort Worth and San Francisco. Each of these acts as a clearing house for a number of area circuits, or outlying "loops," collecting data from observation points on these loops and providing the area circuits with data from other parts of the country.

Teletype electronic communications equipment at the Interchange Centers carries out an automatic program of sequentially calling data-originating stations, classifying messages by priority, selecting only those weather items wanted at regional stations, and delivering them to the area circuits—while maintaining the ability to handle emergency traffic when required.

Ultra-fast communication between Interchange Centers is provided by Teletype punched tape equipment operating at 850 words per minute, utilizing the Data-Phone concept. Stations on outlying loops are equipped with Teletype Model 28 page printer and punched tape units. Speed-conversion equipment permits automatic interoperation between the national circuit and the local loops. Thus the new system, which serves some 2,400 locations, can report weather conditions from any part of the country in a matter of minutes.

The FAA, through the years, has followed a program of continually upgrading its facilities to meet the needs of the nation's growing air traffic. Teletype Corporation is proud of its part in providing communications equipment for this vital service.

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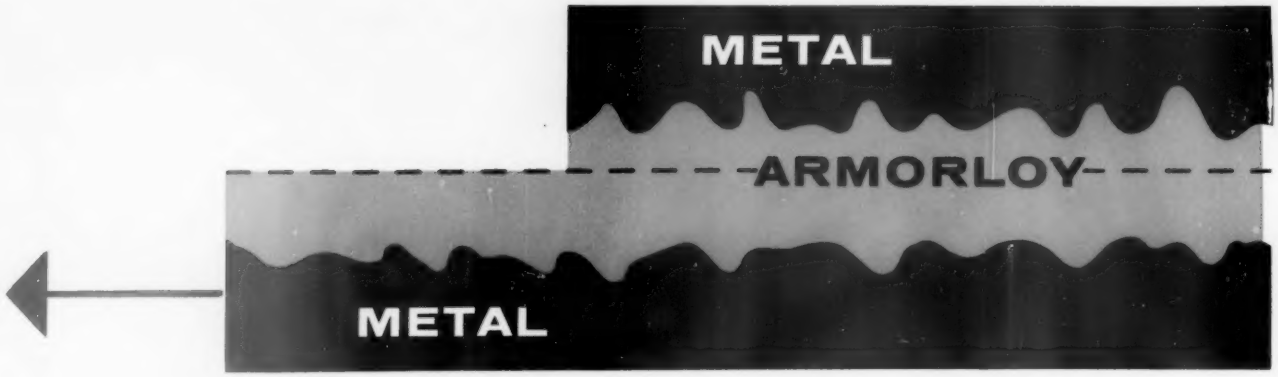


NEW A. O. SMITH ARMORLOY CAPACITY TO PETROLEUM METERS

New solid film lubricant features exceptional corrosion resistance qualities

ARMORLOY — a new, unique lubricating film application is now standard on A. O. Smith petroleum meters. Armorloy is the same type of solid film lubricant which has been used with great success on jet and rocket engine applications.

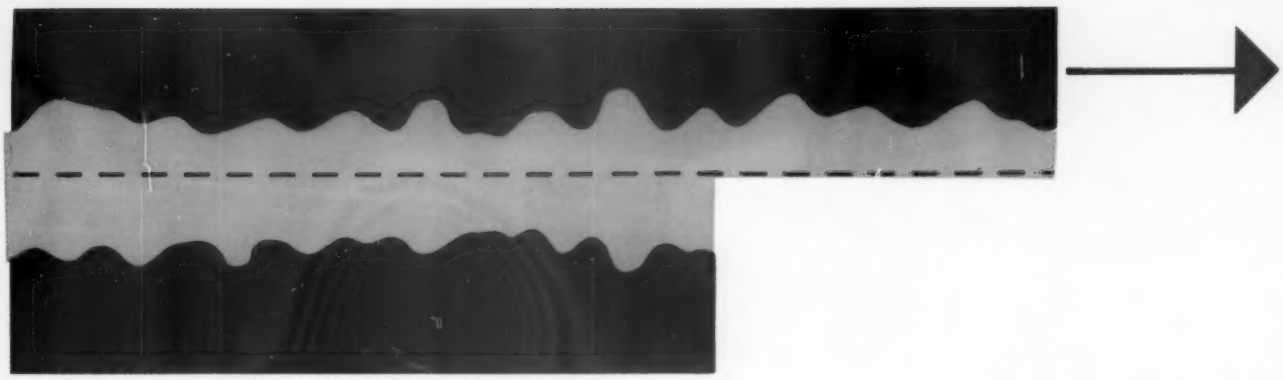
Tough as nails, the new A. O. Smith Armorloy process is especially valuable in fighting the normal corrosive action of some metered fluids. Armorloy also provides maximum protection against wear and friction for contact components because it greatly increases the self-lubricating ability of the meter.

You can't take it off without removing the basic metal — Armorloy is sprayed onto the metal surface of all internal metal components, then baked at 300 F for one-half hour. After this scientifically controlled thermosetting, Armorloy is on to stay.

Thanks to the introduction of Armorloy — plus important additional changes — A. O. Smith is also proud to announce the *new capacity ratings* for its complete line of line and high pressure meters.

Armorloy is just another step in A. O. Smith's far-reaching design program to make petroleum meters serve your industry better!

SEND FOR ARMORLOY SAMPLES! Rub them together, feel — and test — Armorloy's outstanding lubricated surface. Simply fill out the coupon and mail.



PROCESS ADDS LIFE AND EXTRA AT NO EXTRA COST TO YOU!

New Armorloy process helps increase meter capacity as much as 25%

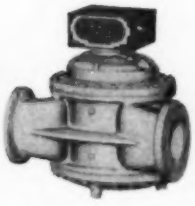
LINE METERS

S & B-13
130 GPM

S-28
280 GPM

S, AS & AB-42
420 GPM

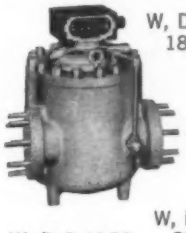
S, AS & AB-60
600 GPM



S & AB-100
1000 GPM

B-170
1700 GPM

HIGH PRESSURE METERS



W, D & M-13
185 BPH

W, D & M-28
400 BPH

W, D & M-42
600 BPH

W, D & M-60
860 BPH

W, D & M-90
1285 BPH

W-170
2430 BPH

B & W-250
3570 BPH

B & W-875
12500 BPH

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Company .....
City ..... Zone ..... State .....

Trans-Canada Pipe Lines Limited Chooses Worthington SUTC's . . .

FOR FIRST FULL AUTOMATION

At central control, the dispatcher pushes a button. At the compressor station miles away, a solenoid throws an air valve. Engine and compressor cylinders begin purging . . .

At 6 seconds, ignition actuates, fuel is admitted and the engine slowly accelerates toward 160 rpm. At 20 seconds the compressor cylinders stop purging. In 5 minutes, the engine-compressor is ready to be brought on line.

This is a glimpse of normal operation of Trans-Canada Pipe Lines Limited's Maple Station—the first to be fully automated by this pipeline company. Three Worthington SUTC engine-compressors operate in pre-set sequences according to signals from the dispatcher who, though 25 miles away, could be a thousand.

These new SUTC's have a higher compression ratio for increased efficiency; improved handling of heat load through new computer-designed Turbo-Chargers; and new bearing construction. Cylinder parts and Double Deck valves were manufactured in Canada.

The station organization chart shows the benefit of these automated SUTC's. This station has no operators. This saves initial cost of four houses and salary and overhead for the operators.

For complete information on SUTC's for automated or conventional installations, call your nearest Worthington District Office. Or write Worthington Corporation, Dept. 43-22, Buffalo, New York. In Canada, Worthington (Canada) Ltd., Brantford, Ontario.

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PRODUCTS THAT WORK FOR YOUR PROFIT

6" TO 36"

What Size Line Pipe Do YOU Need?

Armco Line Pipe can meet your requirements. A wide range of diameters (6″ to 36″) combines with wall thicknesses from .109 to .500 to give you the **exact** combinations you need. You don't pay for **excess** steel.

strength, economy, versatility

You're sure to get the strength you want with Armco Line Pipe. Tests prove that the maximum residual stress in Armco Pipe is about 90 per cent less than in many commonly used pipes.

Let us talk with you about **your** pipe line requirements. Just mail the handy coupon.

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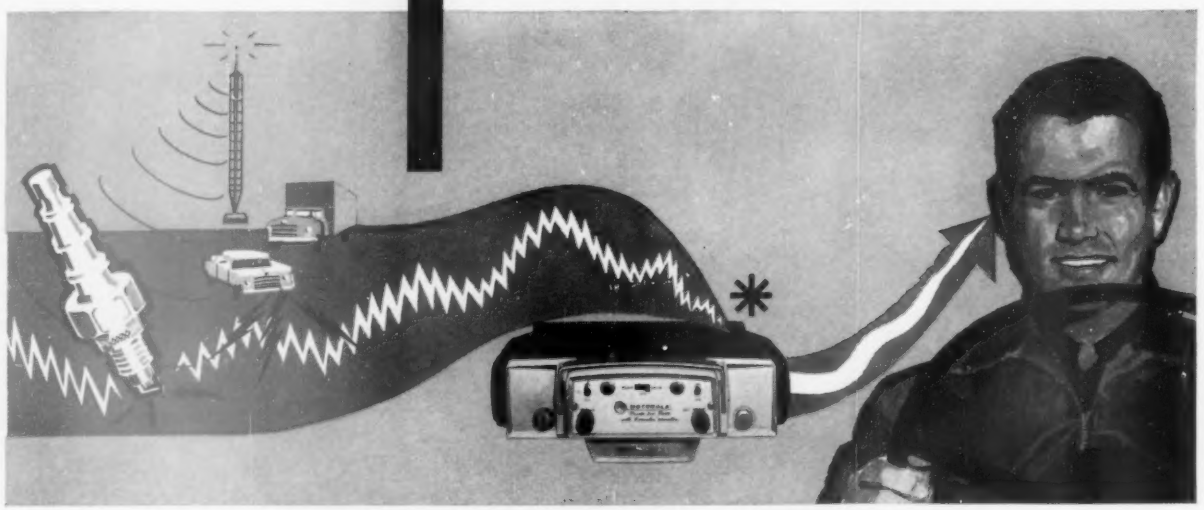
ARMCO Drainage & Metal Products

new...Motorola MOTRAC radio with EXTENDER operation



✱CUTS OUT IGNITION NOISES

Dramatically Improves Overall Efficiency In 24-50 mc 2-Way Radio Systems

Motorola MOTRAC radio with Extender operation puts ignition noise suppression where it does the most good—built right into the receiver. Here it suppresses ignition noises from your own vehicle as well as those in the vicinity...providing the answer to the biggest problem in low-band 2-way radio systems today.

First and foremost, Extender operation improves reception throughout your system. In as much as ⅘'s of your territory, ignition noises can garble your messages. Now messages are clear. "Hash" caused by ignition noise is gone. *Second,* you can "extend" useable operating range where ignition noises are high. Motorola Extender operation suppresses disrupting ignition noise on weak, fringe area signals allowing the message to come through clearly—right out to the limits of your radio coverage. *Third,* you can reduce interference from other radio systems (extraneous messages, ringing and other noise interference known as intermodulation)... just flip the switch on the control head.

"MOTRAC" is a trademark of Motorola Inc.

HEAR FOR YOURSELF

Send in coupon NOW
for a free, on-the-job recording...
listen to the dramatic
difference in message clarity.

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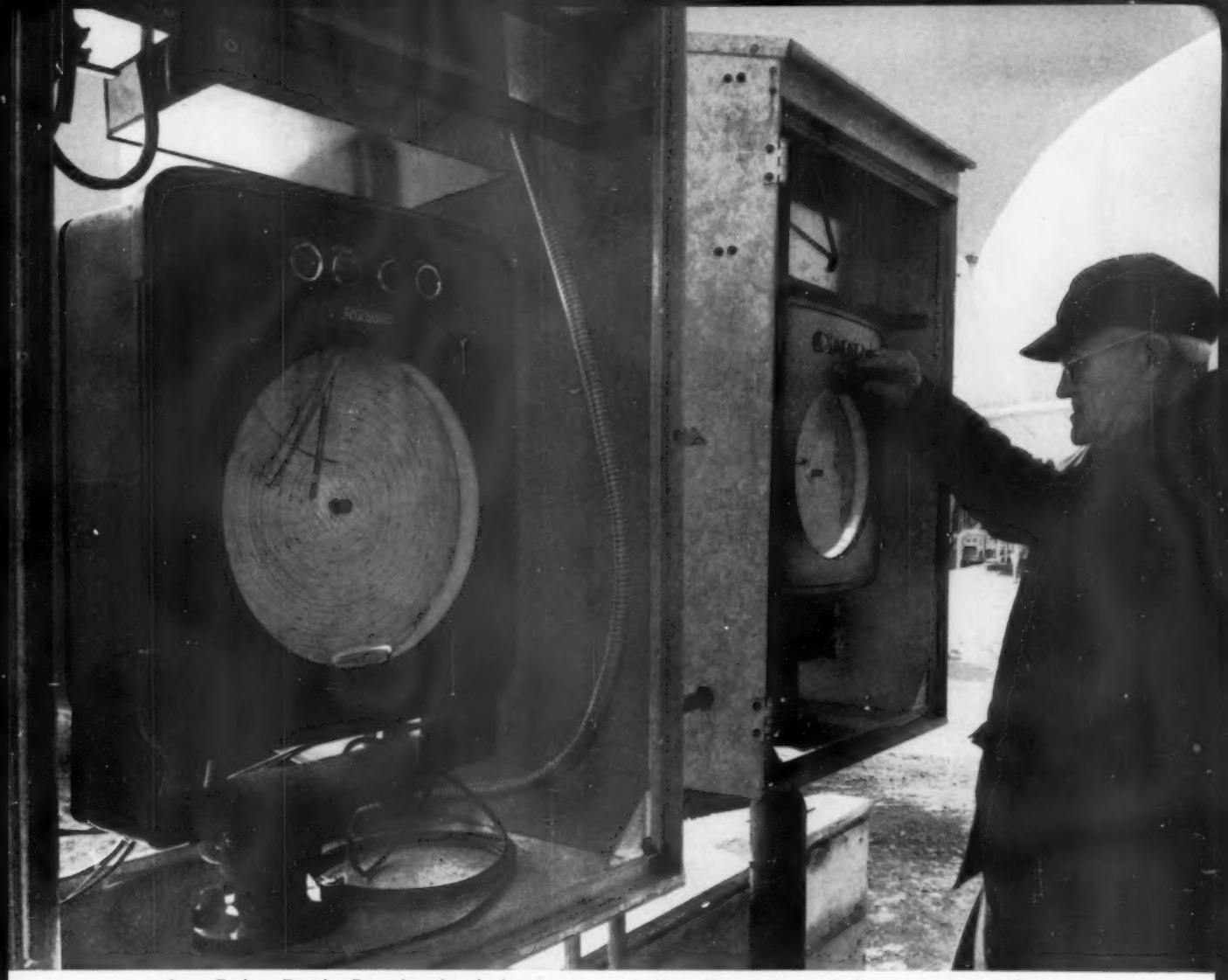
City _____ Zone _____ State _____

MOTOROLA 2-WAY RADIO



2-pen Foxboro Dynalog Recorders chart both upstream interface profile and station profile on Phillips' two pipelines. Upstream record allows operator to select best cut point well in advance of interface's arrival.

Automatic Foxboro interface detection system eliminates guesswork at Phillips pipeline terminal

operators get interface profiles in advance...know exactly when to switch tanks

There's nothing haphazard about interface detection at the Phillips Pipe Line Company Terminal in East Chicago, Indiana. A Foxboro Interface Detection System sees to that.

This unique Foxboro system is based on the fact that even slight differences in grades or brands of petroleum products have measurably different dielectric constants. Sensitive Capacity Dynalog* Recorders measure this difference, both at the pipeline delivery station, and at a point 3 miles upstream. Foxboro Teletax* Telemetering brings the two measurements together on a single chart at the delivery point.

From the shape of the upstream record, the operator selects the best cut point and sets his index. When station interface record matches index, switch-over is made.

Phillips dispatchers find their Foxboro system eliminates sampling and guesswork — cuts product contamination to a new minimum. It can do the same for you. Ask your Foxboro Field Engineer for full details, or write for Bulletin 20-11. The Foxboro Company, 389 Norfolk Street, Foxboro, Mass.

Reg. U.S. Pat. Off.

FOXBORO

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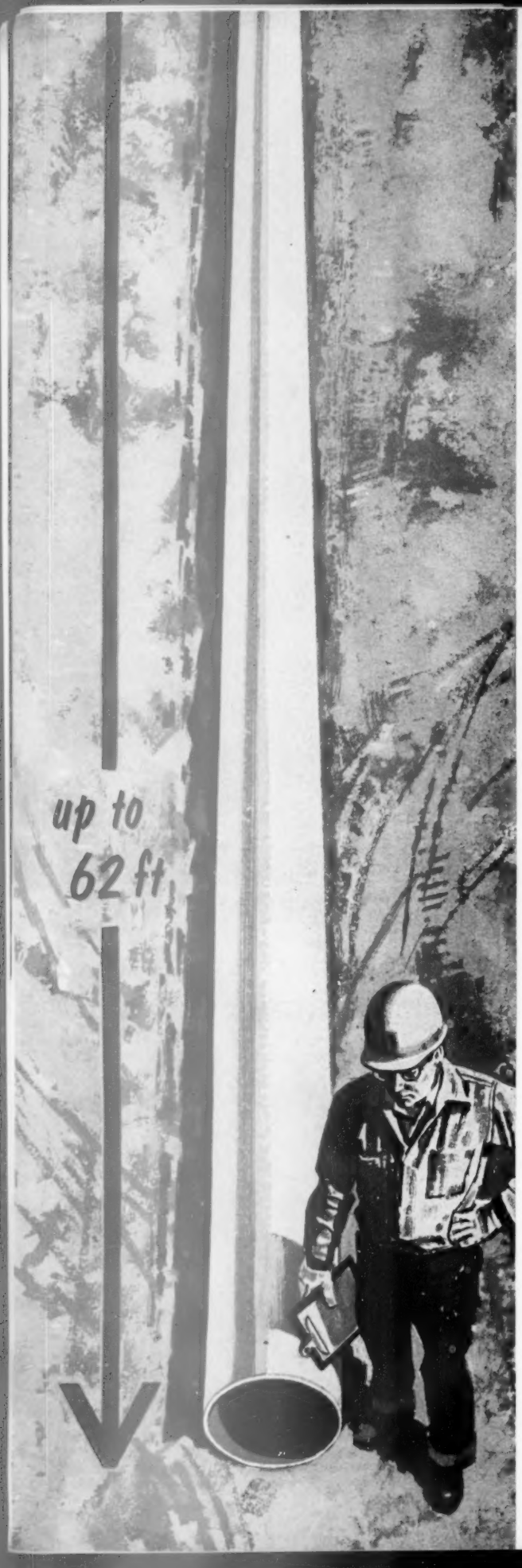
Capacity probes at upstream measuring point, and at terminal (shown above) measure dielectric constant of product passing through pipeline. Upstream measuring station is unattended — profile is telemetered to Dynalog Recorder at terminal.



long lengths for economy

Long lengths of pipe mean fewer welds in the field . . . and fewer welds mean greater economy. It's as simple as that.

Bethlehem produces electric resistance-weld line pipe in lengths to 62 ft. Diameters range from 5 5/16 in. through 16 in. OD. It's all first-rate pipe, meeting API 5L (Grades A or B) or 5LX (X42, X46, or X52) specifications.

We make ERW pipe at Sparrows Point, Md., where we also produce continuous buttweld line pipe in sizes from ½ in. through 4½ in. OD in strict conformity with API 5L specifications.

BETHLEHEM STEEL COMPANY

BETHLEHEM, PA.

BETHLEHEM STEEL

For a full line of line pipe

thick walls for safety

3/4 in.

When pipe lines pass through built-up areas, safety becomes a primary consideration. The applicable codes often demand special practices, including thick-walled pipe.

That's where Bethlehem comes in. We make line pipe with ¾-in. walls from 18 in. through 42 in. OD, in 40-ft lengths. In fact, we are supplying a major gas transmission company with 36-in. OD pipe with walls measuring .844!

Bethlehem's large-diameter line pipe is electric fusion-welded and cold-expanded at our Steelton, Pa., mill—probably the most modern in the industry.

Steel

for Strength . . . Economy . . . Versatility

Export Sales: Bethlehem Steel Export Corporation

call BETHLEHEM STEEL

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. . . gets the best service, too!

The Insley service network includes over 100 dealer locations throughout the U. S. and Canada. Each dealer has trained servicemen and is well stocked with genuine Insley parts . . . ready to handle virtually any service problem on an around-the-clock basis. Consider the importance of service and parts when you buy a new machine—and you'll buy an Insley every time.

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HERE'S WHY WESTERN GEAR PIPELINE DRIVES ARE IN WORLD-WIDE SERVICE

Outstanding records of *reliable* performance under all types of operating conditions with a minimum of maintenance attention have established Western Gear pipeline drives as the standard of comparison in the industry. Reliability doesn't just happen . . . it requires top engineering and manufacturing techniques teamed with broad experience in all types of pipeline drive requirements.

Check these important features found in every W G pipeline drive:

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2. Tough double helical gearing: precision hobbed and shaved from high alloy steel forgings, heat treated for years of dependable service.

3. Sleeve-type journal bearings: babbitted tin base alloy, bronze backed. Larger units have removable caps for easy accessibility.

4. Rugged housings: cast or fabricated, depending on unit size. Generous internal rib and gusset reinforcing for clean appearance and strength.

5. Flexible lubrications systems: standard integral type or special systems to meet any installation requirement.

6. Rigid quality control: close tolerances, mill-to-finished product material inspection including magnetic and ultra-sonic surveys where necessary.

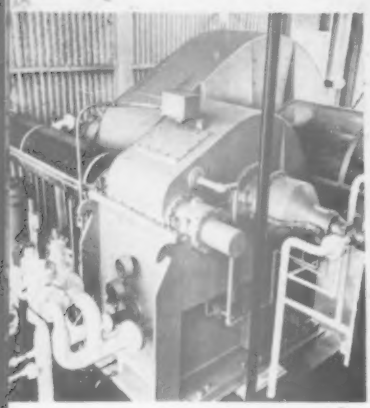
7. Unsurpassed experience: scores of single or multiple stage drives in world-wide service—Transwestern, Columbia-Gulf, Texas Eastern, Transmountain, Warren Petroleum, Union Oil, Trans-Arabian, Petroleos Mexicanos, Spanish Pipeline, Richfield Oil, Great Lakes, Mid-Valley and others.

For complete information on Western Gear pipeline drives, write, wire or phone:

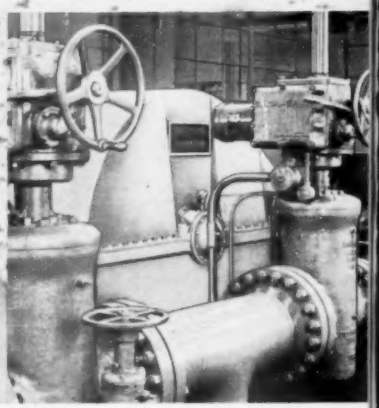
WESTERN GEAR CORPORATION
Industrial Products Division
P.O. Box 126, Belmont, Calif.
LYtel 3-7611

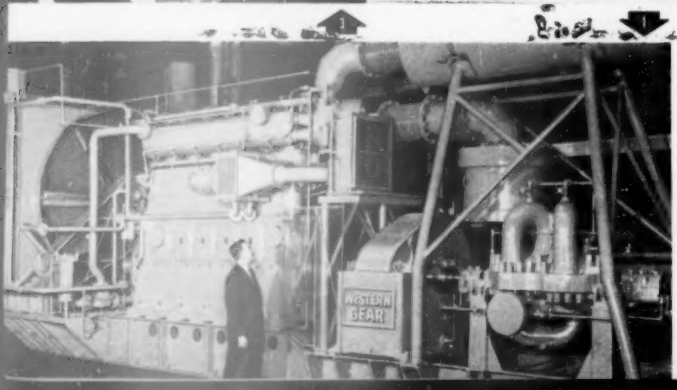
WG PIPELINE DRIVES ARE BACKED BY 70 YEARS OF SERVICE TO INDUSTRY

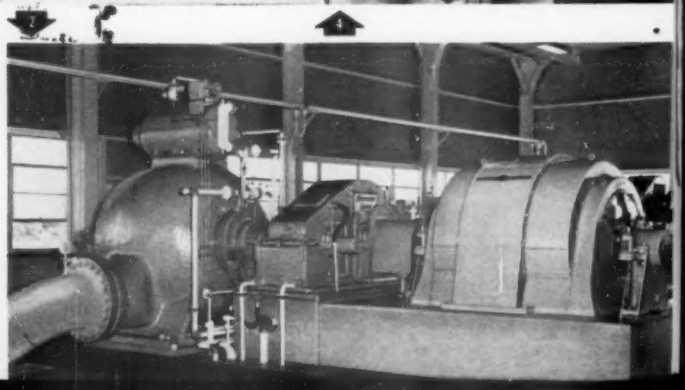
On the long run . . . **QUALITY COSTS YOU LESS!**



1. *Western Gear hi-speed unit boosts 600 RPM 925 HP at engine input to a 3550 RPM centrifugal pump at a pumping station of American Independent Oil Co. in Kuwait.*
2. *One of 2 Western Gear Model 300HS150 units installed for El Paso Natural Gas Company in its Leupp, Arizona station . . . 5750 HP from 1200 RPM electric motor to 8500 RPM centrifugal compressor.*
3. *One of 20 two-stage hi-speed drives which step up 5000 HP 327 RPM engines to centrifugal compressors at 6055 RPM for Columbia-Gulf.*
4. *Western Gear speed increasers like this are used exclusively on Mid-Valley's 1,000-mile pipeline. A total of nine 1200 HP 450/3600 RPM and seventeen 1700 HP 327/3600 RPM units are in service.*

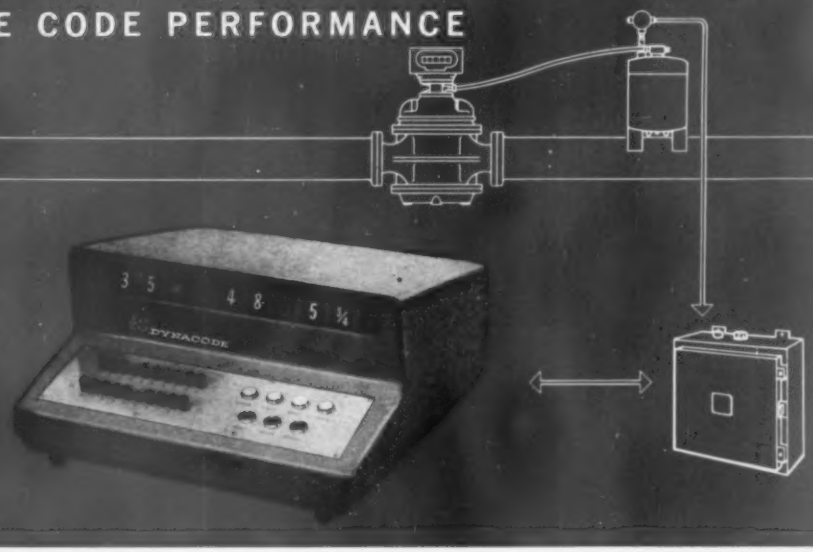






DYNEL DYNACODE TELEMETERING SYSTEM

A NEW HIGH-SPEED REMOTE MONITORING SYSTEM BASED ON 6 YEARS° OF FIELD PROVEN VAREC PULSE CODE PERFORMANCE



The 3-second DYNACODE telemetering cycle is activated by either push-button (shown here) or dial to contact data point. Response goes from data point, through a transmitter to a remote multi-point selector which then sends the data to the receiver where it is decoded and digitally displayed.

Dynel engineers—utilizing the performance proved concepts of Varec's famous Pulse Code system—have developed the significantly advanced DYNACODE telemetering system for remote readings of liquid level, temperature and P.D.M.

This single-channel, "error-proof" system combines the proven reliability of the basic Varec system with a digital readout time of 3 seconds per point...readout accuracy of 1/16 inch...readout capacity of an unlimited number of points...and readout versatility that permits the system to be tied into a general purpose computer for inventory, billing, and similar functions.

Solid state components are used at key points in the receiver design for longer, maintenance-free life. And DYNACODE, like Varec's Pulse Code, has an instantaneous alarm system without scanning delays.

The high-speed DYNACODE System offers these advantages:

Reliability: Design based on 6 years of performance in scores of pipeline and refinery applications.

Data Display: Illuminated, in-line digital display includes point and function identification, digital data to 6 significant figures and liquid level to 1/16" increments.

Fast Response: data from any given point is gathered and digitally displayed in just 3 seconds.

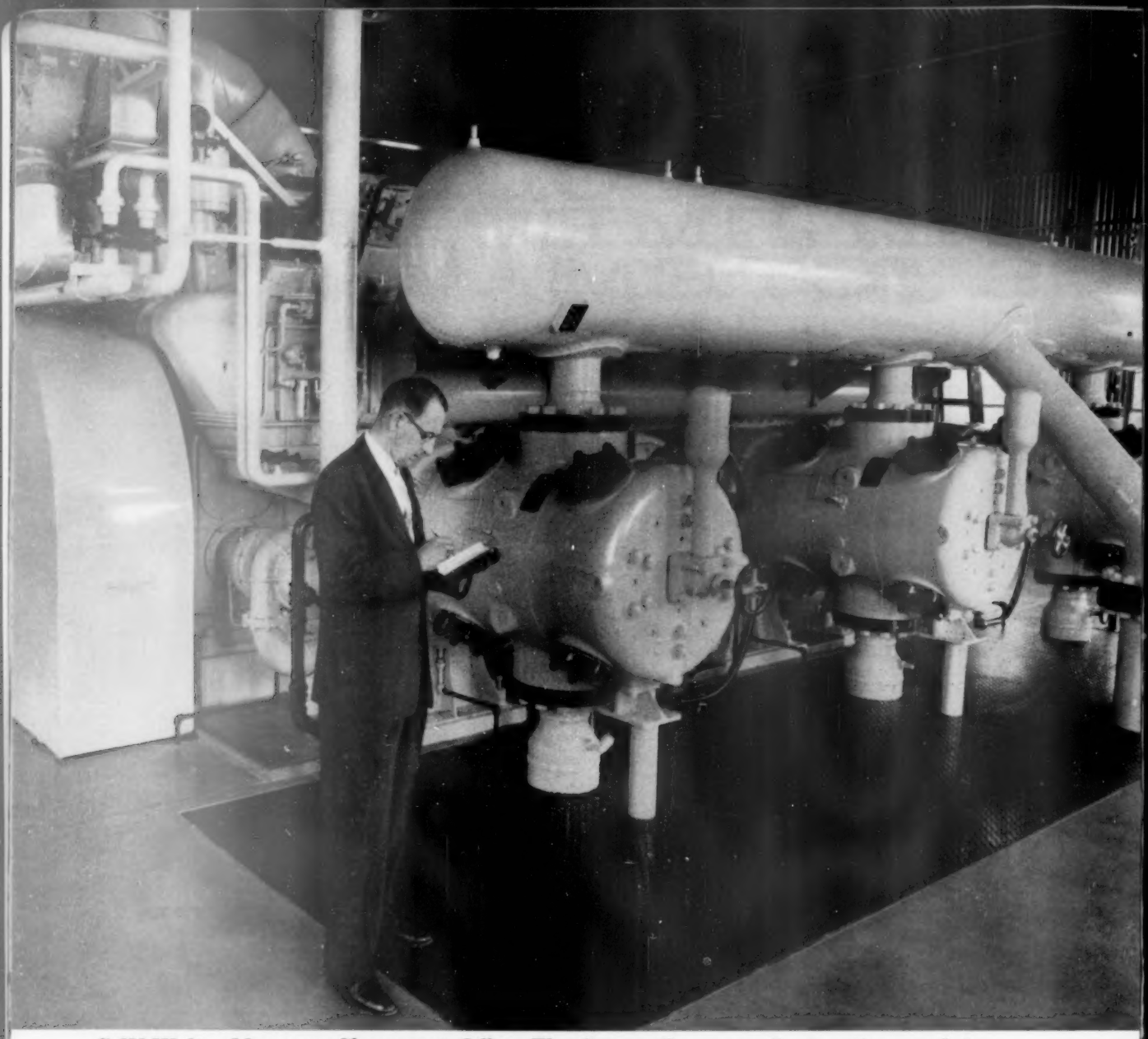
Flexibility: Designed on building block principle that permits a great variety of system arrangements...DYNACODE is compatible with all standard systems of measurement.

Readout Variety: digital output provides a variety of readouts, including visual display, paper tape, typewriter, etc. Output is compatible for use with general purpose computers.

For complete information, see DYNACODE at the ISA Show, Los Angeles Sports Arena – Booth #170. Or write for Bulletin 301, Dept. PTE-1600-2

DYNEL, Inc., *a subsidiary of Varec, Inc.*

12923 S. Spring Street, Los Angeles 61, California • Branches and Representatives in Principal Cities



C. W. Woltz, *Manager, Shreveport Office, The Cooper-Bessemer Corporation, explains...*

How Carthage Station increases efficiency as it expands

The Cooper-Bessemer series-turbocharged compressor shown above delivers about 35% more power than its predecessor of the same bore, stroke and speed. To the Carthage, Texas, Station of United Gas Pipeline Company, this means less fuel consumption and lower costs for installation and operation.

Carthage Station has expanded twice since it started in 1952, and each time, has boosted efficiency by specifying the latest Cooper-Bessemer advancements. The original installation comprised five 440 hp GMV-4-TF units. The first addition (1954) consisted of four 1350 hp GMVA-10 units with the economies of centrifugal scavenging. The unit shown . . . an 1800 hp GMVC-10 compressor was added in 1960, providing the further economies of series turbocharging. All 10 Cooper-Bessemer units are in operation and are giving highly satisfactory service.

To get the latest economies for *your* compression facilities, call in the nearby Cooper-Bessemer Application Engineer.

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINES: GAS · DIESEL · GAS-DIESEL
JET-POWERED GAS TURBINES

WHY 754,900 FEET OF SPANG PIPE WERE USED FOR NEW SEADRIFT PIPELINE

Seadrift Pipeline Corporation, a subsidiary of Union Carbide Corporation, used three quarters of a million feet of SPANG seamless line pipe in their new 108-mile dual pipeline from Seadrift, Texas, to the Humble Oil Company gas plant near Ella, Texas.

There are many reasons why oilmen feel safe when they specify SPANG pipe. They know that SPANG has taken every precaution to assure strength, ductility and uniformity of the pipe. SPANG pipe has been serving industry needs successfully since 1840. It is produced by National Supply, the world's largest supplier of oil country equipment and products.

These are a few of the reasons why SPANG pipe is preferred by oilmen. The next pages cover additional reasons.

PIPELINERS FIND SPANG SEAMLESS PIPE IS

754,900 feet of SPANG seamless line pipe were used by the Seadrift Pipeline Corporation, a subsidiary of Union Carbide Corporation, in this new pipeline from Seadrift, Texas, to Ella, Texas. Order was made up of 3½", 4½", and 6⅝" O.D. pipe.

DUCTILE, EASY TO WELD, UNIFORMLY ROUND

Stringent quality control in every phase of production and shipment. This is probably the most important reason for the superiority of SPANG pipe in gathering, distribution and transmission lines.

Quality control is a specialized business in National Supply's modern Ambridge mill, where SPANG pipe is made. This control starts with the chemical and physical properties of the steel and is carried through every step of production and inspection.

The finished pipe is subjected to thorough testing through internal and external surface inspections, hydrostatic tests and dimensional controls, such as O.D., wall thickness, end bevel and straightness checks.

At the end of production and inspection cycles, and before SPANG is stenciled on the pipe, we are sure it meets the appropriate API specification.

Uniformity of SPANG pipe is an important benefit. The uniform roundness speeds welding. And pipeline crews like the SPANG ductility for operations over rough terrains.

SPANG seamless line pipe for gathering, transmission and distribution lines is readily available in sizes from 2 inches (nom.) through 14 inches O.D., and in specifications API STD. 5L and API STD. 5LX.

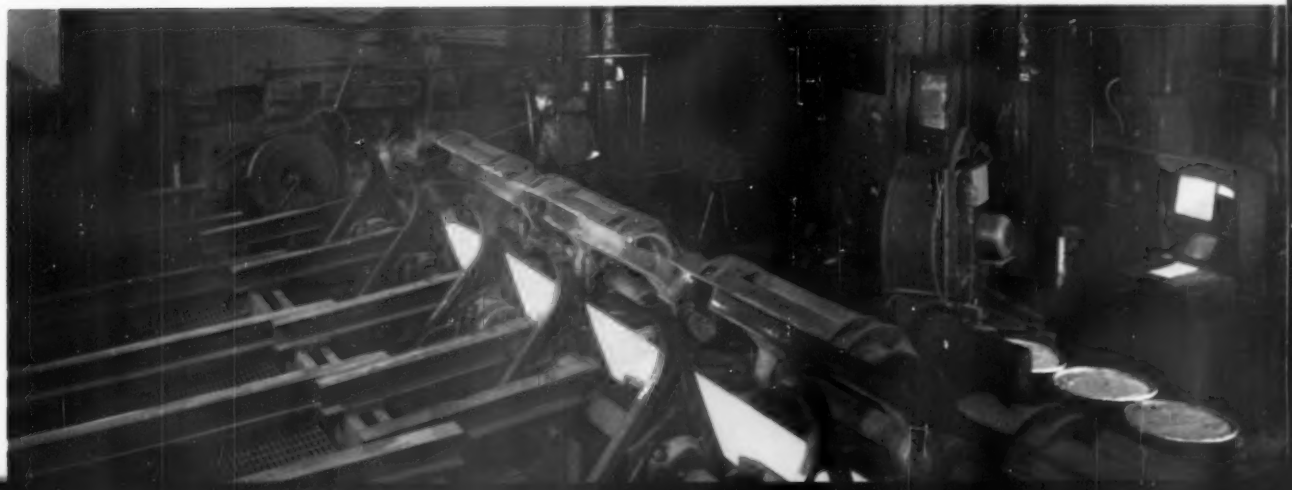
Next time you buy pipe, play it safe. Order SPANG seamless pipe from your National Supply representative, or write to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pa.

Stenciling the SPANG name is final step in production of high-quality pipe under standards that meet API specifications.

Steel's Symbol of strength, long life, and economy

Steel

SPANG pipe is produced by National Supply at Ambridge, Pa., in a modern pipe mill, where quality control is the prime consideration.



SPANG PIPE SPEEDS INSTALLATION OF GATHERING AND FEEDING LINES

National Supply also produces SPANG CW butt-weld pipe under stringent controls. Every length is hydrostatically tested and inspected for thread quality and uniformity.

All SPANG pipe is made of carefully selected steel that meets the toughest standards. This control assures you of pipe that is easy to work, because it is easy to cut, bend, thread and weld.

Call your nearby National Supply representative, or write to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pennsylvania.

Gathering line service is one of many oil field applications for SPANG CW pipe. In addition to gas, oil and water lines, you can use it for many structural purposes.

ARMCO National Supply Division

TAPECOAT® PROTECTION...

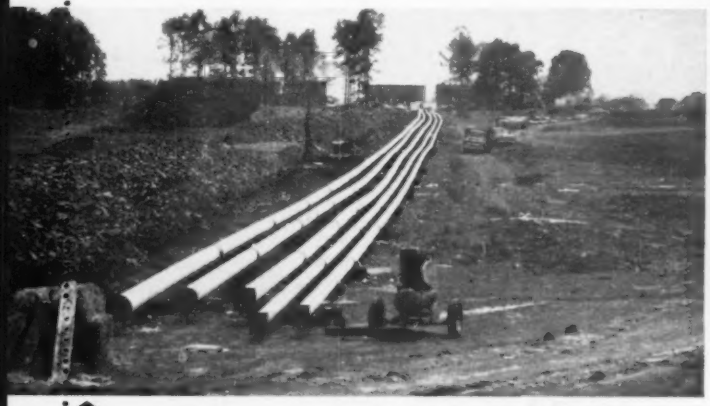
Works for You Anywhere!

NATURAL GAS lines at compressor and meter stations give years of maintenance-free service when protected by TAPECOAT, the coal tar coating in handy tape form.

GAS DISTRIBUTION lines of large diameter can readily be protected with TAPECOAT to withstand the abrasive and corrosive climate in underground service.

CABLE AND CABLE SPLICES in communications service are effectively and economically protected by TAPECOAT.

Lines in **OFF-SHORE DRILLING** operations need joint protection equivalent to the mill-wrapping on the pipe. TAPECOAT is most economical because it gives lasting protection in underwater service.



AIRPORT FUEL LINES need the quality joint protection assured by TAPECOAT. It is easy to apply by spiral or "cigarette" wrapping depending on the size of the pipe. No training needed.

UNDERGROUND GAS STORAGE facilities can be "buried and forgotten" when protected by TAPECOAT. Note protection of tanks, pipe and pipe joints.

STEEL MILL water lines in this new plant are joint-protected with TAPECOAT. TAPECOAT can be used to advantage to protect any steel surface in underground service, as proved since 1941.

Lines buried in cinders in **RAILROAD YARDS** need the sure protection provided by TAPECOAT. There's a size for every purpose from 2" to 24" in width.

Write for full details today

GEM GAS EQUIPMENT MANUFACTURERS GROUP MEMBER

The TAPECOAT *Company*

Originators of Coal Tar Coating in Tape Form

1567 Lyons Street, Evanston, Ill.

Manufactured and Distributed in Canada by
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25 Haas Road, Rexdale, Ontario.

Six Months Ahead of Schedule

by P. A. MacCormack

It's a feat to finish any major international pipeline project six months ahead of schedule. It's a wonder when it involves hot desert, 120 miles of rock ditch, flooded plains, major rivers, primitive communications, the necessity of creating villages where only vast expanses exist, and the operational necessity of leap-frogging spreads.

With proper organization, a realistic work schedule and plenty of enthusiasm, Turriff-Burden, Ltd., is doing just that. Originally scheduled as a 112-week project, a 315-mile, 30 and 32-in. crude oil pipeline in Iraq is now in its closing stages six months early.

Iraq Petroleum Co. in September, 1959, awarded the contract to the joint enterprise of

Pipe gang composed of Iraqi workmen.

Turriff Construction Corp., Ltd., of London and Warwick, England, and the O. R. Burden Construction Corp. of Tulsa, Okla.

As soon as the "go-ahead" was given, Turriff-Burden purchased new equipment (the bulk of it from the United States), shipped it to the Turkish port of Iskenderun, then transported it by rail into Iraq to a base depot set up at Baiji.

By early November enough plant had arrived for pipelaying to start, and at the end of the month all equipment was on the job.

The contract was a looping one, split into two main sections — 250 miles in north Iraq, from Kirkuk to the Syrian frontier paralleling the existing I.P.C. pipeline which continues through Syria to Tripoli, Lebanon; and 65 miles in southern Iraq from Zubair to Fao.

The northern 250-mile section was divided into eight loops, each of which was tested on completion, tied into the existing 30-in. line and immediately commissioned. The loops were not laid consecutively but in a sequence which would take into account pumping facilities and give maximum benefit to throughput. This necessitated a complicated program of leap-frogging the one main spread and careful planning to the last detail to avoid lost time during the many moves.

For the same reason, camp construction called for a high degree of organization. The right-

of-way was remote from townships, so national and expatriate personnel had to be housed in self-contained camps providing all facilities; air conditioning, refrigeration and heating according to local conditions; water supply; and social services.

In some locations every drop of water had to be hauled 40 miles. A small town was needed to house the personnel on the job. In the desert there was just a vast expanse. Everything had to be brought in.

Consequently, in the early stages, camp construction had difficulty in keeping up with the contract, so rapidly had the spread fired up. Within two months, however, the special organization to look after this aspect was forging ahead with the same kind of enthusiasm that was evident in those working on the line itself. After that, camp facilities were always a jump ahead of the leap-frogging spread.

Spread to South in Summer

Apart from the operational necessity of dodging backward and forward on the northern section of the work, there was a major interruption in the summer of 1960 when attention had to be diverted to the southern area.

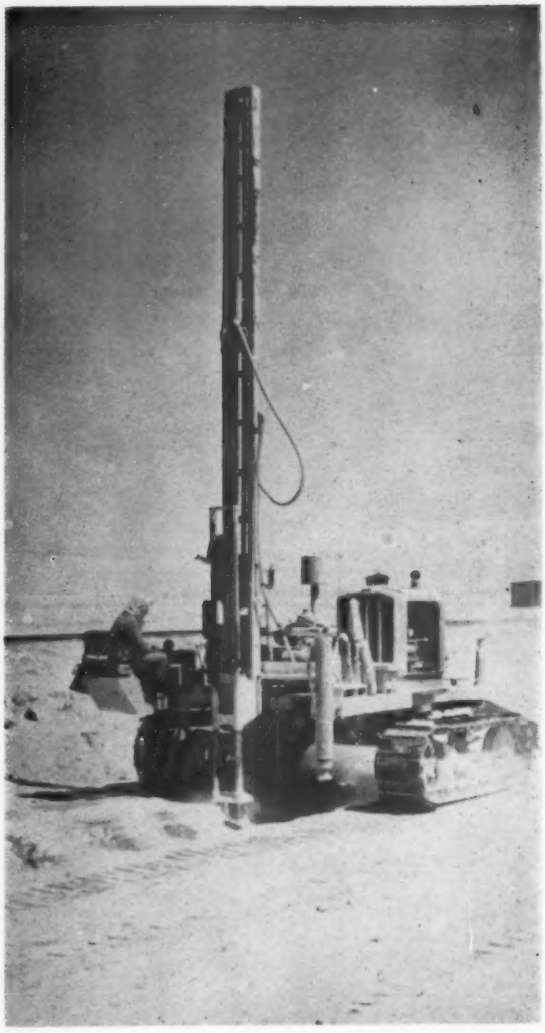
The line here runs across wet, muddy, boggy salt flats that are subject to flooding in the winter, so work in that part of the country had to be done in the summer. Therefore a halt was called temporarily in the north, and the entire spread with all its plant moved 500 miles to the south, Basrah, and later similarly moved back to carry on in the north.

These moves were big undertakings, for facilities for transporting the heavy equipment were not of the best. Bridge restrictions on the roads made the use of rail obligatory for the heavy items, and there was a shortage of railcars of the right gage for the single-track line. Nevertheless, more than 2000 tons of equipment were moved to the south and back to the north again with a loss of only 10 days spread operations each time. The contractor gives credit to the Iraqi Republican Railways for their wholehearted cooperation in this tricky piece of organization.

Communications Primitive

More anxiety was caused from time to time by the fact that communications — the nerves of a pipeline project — were extremely primitive.

Road transport was uncertain, as the line in the north was divided by the Tigris and Euphrates rivers which had to be crossed by ferries. Flooding would stop the ferries at unpredictable intervals. Radio was not available due to national security considerations.



Blastholer machine making shot holes for blasting.

The difficulty of communications was overcome partly by detailed planning ahead to rule out unforeseen snags and by organizing remote sections on an autonomous basis so that problems could be dealt with on the spot. This put a high degree of responsibility on the initiative of the supervisory staff, and was found to work extremely well.

Trained labor among the Iraqi population was not available in the quantity required. Welders and machine operators were particularly hard to obtain. Training schools were established. They were soon changing unskilled recruits into intensively trained technicians whose work stood up to the most rigorous inspection. Within six months all welders and

Backhoe removing rock from ditch after blasting.

Iraqi workmen padding the rock ditch.

Cleaning and priming the pipe.

operators (including those for quadrill and ditching machines) were Iraqi. Expatriates were used for supervisory and training work only.

Even this training program was not the complete answer to the labor problem. Labor was highly localized in the various sheikdoms, and moving from one territory to another frequently meant a changeover of most of the labor force, with all the training to do over.

Climate Challenge

Temperatures varied from freezing during the winter in the north to 130 F, with 90% humidity, in the south, with frequent dust storms during the hot weather.

Nevertheless, except at Basrah, work continued during all the daylight hours. At Basrah, a "concession" was made by starting work at 4 a.m., resting for three hours in the middle of the day, and then carrying on again until dark.

Much of the time gained from the original program was on operations in the south, where 65 miles of 30 and 32-in. pipe were laid in 60 days, instead of the scheduled six months.

This was accomplished while leaving behind in the north a detachment to pull four 16-in. lines across the Tigris and Euphrates rivers (additional to the original contract) and a small ditch spread, which operated through the summer to ensure sufficient ditch through rocky terrain to guarantee continuity of operations on the return of the main spread.

As always, credit for the impressive result of this contract lies largely with the men who worked hard against some very difficult conditions, but they themselves are the first to share

Jack Burden, president, O. R. Burden Construction Corporation, at rock ditch in Iraq.

Turriff-Burden personnel in Baghdad, 1960, left to right: Joe Yagchi, local representative; the late Oscar R. Burden; Glenn Suagee, office manager; H. L. Miller, spread superintendent; P. A. MacCormack, project manager, and writer of this article.

Iraqi welders and helpers.

their credit with the excellent spread equipment sent out to them.

In some cases the machines were specially modified for work in Iraq, and they certainly justified themselves in the rugged conditions encountered. Right-of-way was handled by Caterpillar D-8 and D-7 dozers, stringing by Mack 61's, ditching by Caterpillar D-9's with Kelly rippers and Cleveland 320's, pipelaying by Caterpillar M.D.-7 and 583's, cleaning and wrapping equipment by Crose-Perrault, and dope kettles by Crutcher-Rolfs-Cummings.

The rock ditch provided a lot of headaches as blasting was frequently dissipated through fissures, slowing progress. Eventually drilling and shot-loading techniques were evolved that proved successful. A Buckeye 51 ditcher was used for rock stripping, with the help of Caterpillar D-9's and Kelly rippers. Quadrills and Damco Blastholers did the drilling, and modified Bucyrus-Erie 22-B's backhoed the shot ditch.

Cooperation Outstanding

The quality of workmanship on the job was high throughout, perhaps remarkably so considering the necessity of training raw labor. However, the Iraqis learned quickly. Every weld on the line was X-rayed and passed as perfect before commissioning. The helpful cooperation of inspectors representing the Iraq Petroleum Company facilitated progress. The Iraq government also maintained a helpful interest in the progress of the work and granted many special facilities.

Capital, labor, skill and experience have been pooled on a truly international level to carry out this most important assignment. Without this goodwill on the part of Iraqi officials and people, it is most improbable that such impressive records would have been set. As it is, other supplementary contracts have been awarded to extend beyond the completion of the main pipeline, and the atmosphere is such that the contractor's staff is happy to continue working in Iraq.

The enterprise speaks volumes for the excellent coordination that can be achieved by U. S. and British contractors working in concert. Excellent relations were established between the two parent organizations on this contract and maintained throughout. This Turriff-Burden alliance will continue. The efficiency and enthusiasm that were built up in Iraq will be turned to other important undertakings.

P. A. MacCormack is Iraq project manager for Turriff-Burden, Ltd.

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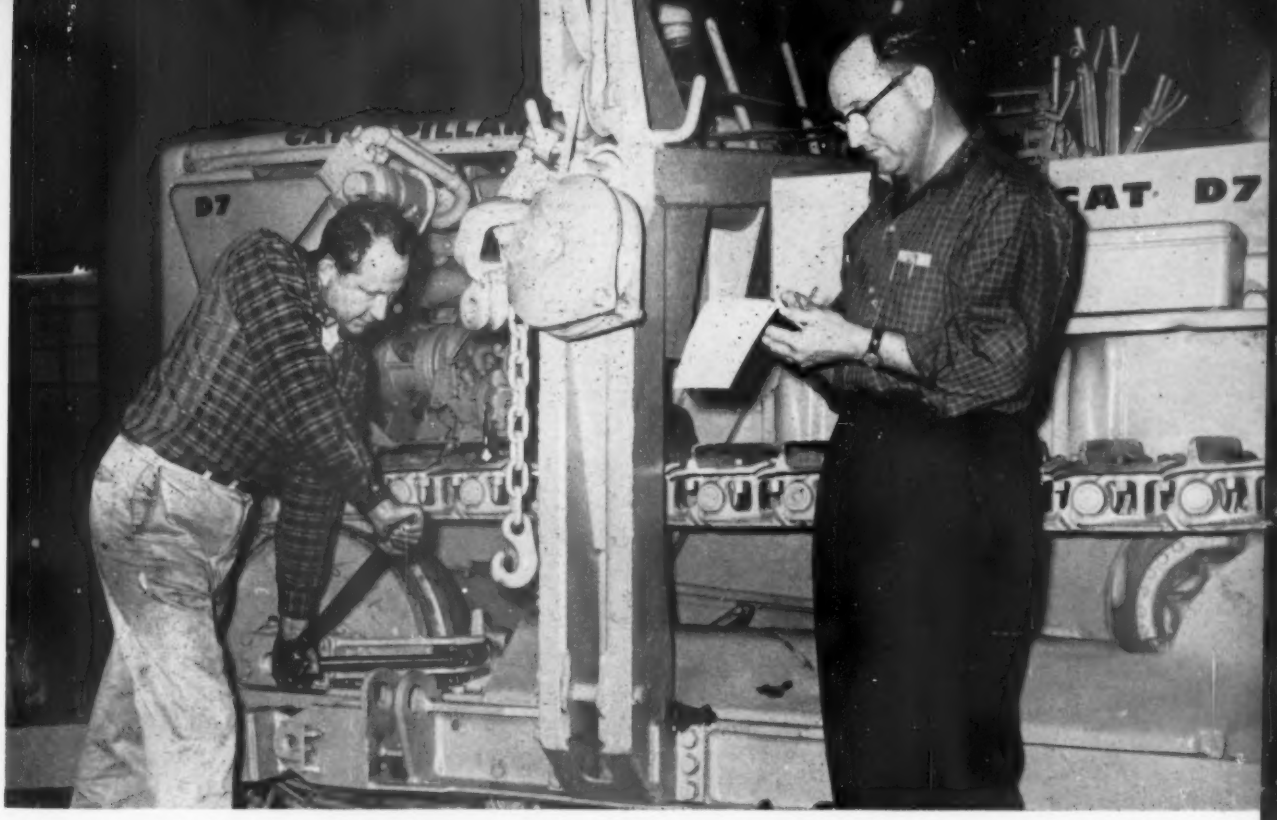


Off-season or during idle periods, when no large amount of heavy construction is in progress, mechanics perform overhaul jobs on larger pieces of equipment such as this D-7 sideboom Caterpillar tractor.

by M. W. Beech — One of a Series on Maintenance

How to Keep a Fleet Rolling

Texas Gas Transmission Corporation's fleet of vehicles racked up the staggering sum of 6,972,909 miles in 1960 — a terrific total on anyone's speedometer. A capable, highly specialized crew of transportation department employees and an efficient program of maintenance and repair kept 'em rolling through rugged terrain, back-country roads, pipeline rights-of-way and in storage fields.

During years of heavy construction along its 4200-mile pipeline system that stretches from the Gulf of Mexico to Lebanon, Ohio, Texas Gas's fleet of vehicles has traveled as much as 7,500,000 miles.

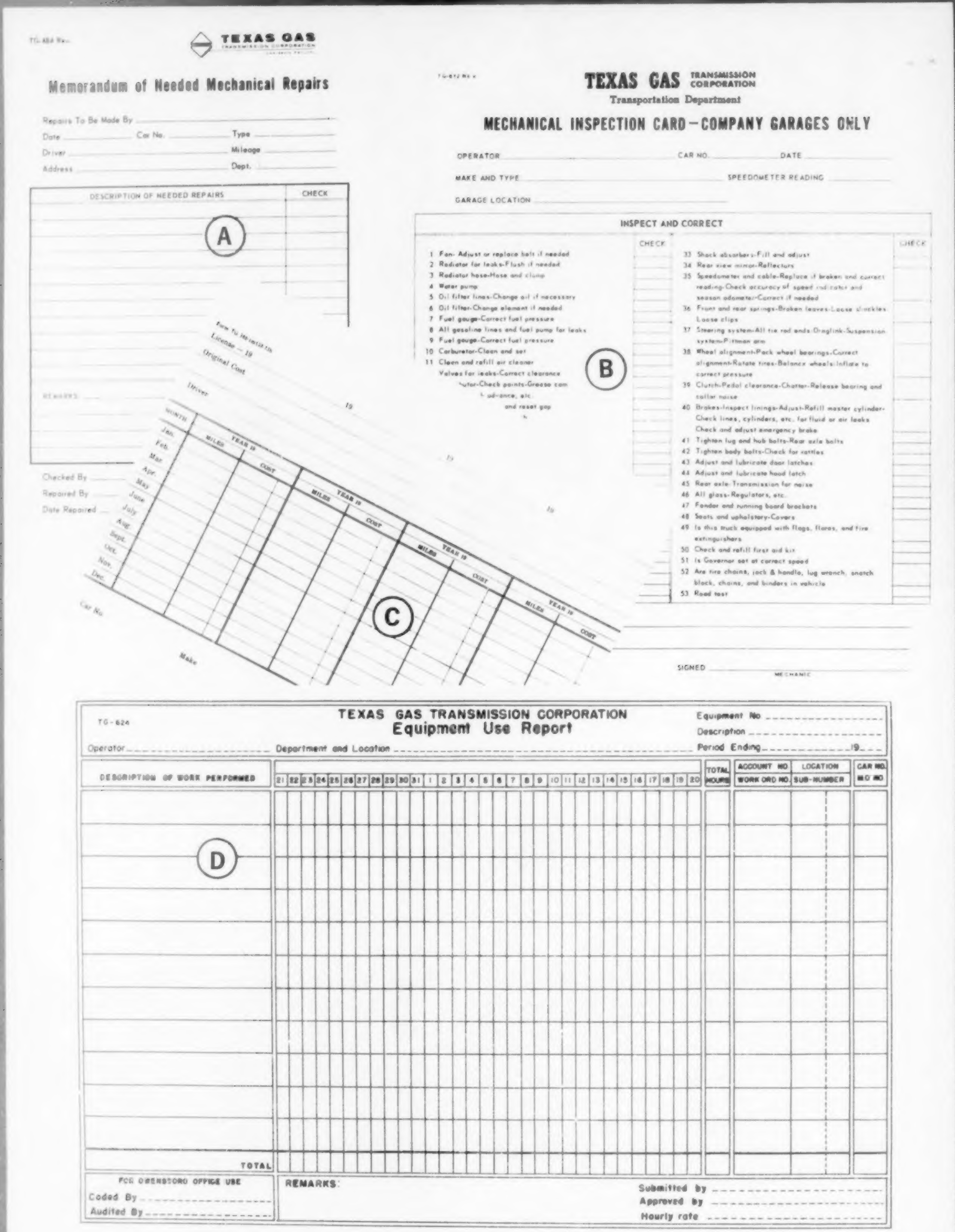
The transportation department maintains and repairs 403 cars and trucks, as well as 650 other pieces of equipment, including trailers, draglines, water pumps, lawn mowers, welding machines, air compressors, crawler tractors, farm tractors and portable electric generators.

Thirty-four employees based in four locations accomplish this with:

1. Comprehensive record-keeping in departmental offices.
2. Pool car garage.
3. Maintenance shop with the latest automotive repair equipment.

Texas Gas also subscribes to the old army theory that first echelon maintenance can stop trouble before it starts, requiring its equipment inspectors to keep constant checks on rolling stock to keep it in top condition. The company figures that if its inspectors succeed in spotting trouble before it happens, a lot of major repair jobs can be avoided.

In connection with the operation, repair, and maintenance of vehicles and other equipment,



TEXAS GAS

Memorandum of Needed Mechanical Repairs

Repairs To Be Made By
Date — Car No. — Type
Driver — Mileage
Address — Dept.

DESCRIPTION OF NEEDED REPAIRS	CHECK

A

Remarks

Checked By
Repaired By
Date Repaired

TEXAS GAS TRANSMISSION CORPORATION
Transportation Department

MECHANICAL INSPECTION CARD—COMPANY GARAGES ONLY

OPERATOR — CAR NO. — DATE
MAKE AND TYPE — SPEEDOMETER READING
GARAGE LOCATION

INSPECT AND CORRECT

1 Fan- Adjust or replace belt if needed
2 Radiator for leaks-Flush if needed
3 Radiator hose-Hose and clamp
4 Water pump
5 Oil filter lines-Change oil if necessary
6 Oil filter-Change element if needed
7 Fuel gauge-Correct fuel pressure
8 All gasoline lines and fuel pump for leaks
9 Fuel gauge-Correct fuel pressure
10 Carburetor-Clean and set
11 Clean and refill air cleaner
Valves for leaks-Correct clearance
...utor-Check points-Grease cam
... advance, etc.
and reset gap

B

33 Shock absorbers-Fill and adjust
34 Rear view mirror-Reflectors
35 Speedometer and cable-Replace if broken and correct reading-Check accuracy of speed indicator and season odometer-Correct if needed
36 Front and rear springs-Broken leaves-Loose shackles Loose clips
37 Steering system-All tie rod ends-Draglink-Suspension system-Pittman arm
38 Wheel alignment-Pack wheel bearings-Correct alignment-Rotate tires-Balance wheels-Inflate to correct pressure
39 Clutch-Pedal clearance-Chatter-Release bearing and collar noise
40 Brakes-Inspect linings-Adjust-Refill master cylinder-Check lines, cylinders, etc. for fluid or air leaks Check and adjust emergency brake
41 Tighten lug and hub bolts-Rear axle bolts
42 Tighten body bolts-Check for rattles
43 Adjust and lubricate door latches
44 Adjust and lubricate hood latch
45 Rear axle-Transmission for noise
46 All glass-Regulators, etc.
47 Fender and running board brackets
48 Seats and upholstery-Covers
49 Is this truck equipped with flags, flares, and fire extinguishers
50 Check and refill first aid kit
51 Is Governor set at correct speed
52 Are tire chains, jack & handle, lug wrench, snatch block, chains, and binders in vehicle
53 Road test

SIGNED — MECHANIC

Date Ac... License — 19
Original Cost
Driver
Month: Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
Year 19 — Miles — Cost
Car No.
Make

C

TG-624
TEXAS GAS TRANSMISSION CORPORATION
Equipment Use Report

Equipment No
Description
Operator — Department and Location — Period Ending — 19

DESCRIPTION OF WORK PERFORMED	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL HOURS	ACCOUNT NO. WORK ORD NO.	LOCATION SUB-NUMBER	CAR NO. MO NO.
TOTAL																																			

D

FOR OWENSBORO OFFICE USE
Coded By
Audited By

REMARKS:

Submitted by
Approved by
Hourly rate

A. Form used by drivers to report apparent defects, maladjustments, etc., to the company garage. B. This form is completed each time an 8000-mile inspection is performed on an automobile or truck. The original is placed in the permanent records of that vehicle. C. Cardex record is prepared when a new unit is placed in service. It is permanent and shows the driver, monthly mileage and original cost of vehicle. D. Heavy equipment "use" report form.

transportation department office personnel must keep voluminous records on each piece of equipment, in addition to filling out stacks of other allied forms and paper work pertaining to the operation of vehicles.

Although personnel at each location keep certain records, the lion's share of paper work transactions and records-keeping is handled in the general office in Owensboro, Ky. General office employees maintain permanent records on all vehicles and work equipment, keep mileage records, equipment use reports, tire records, issue oil, gasoline and tire credit cards, license vehicles in the various states, secure overweight and oversize hauling permits, and process equipment through city and state motor vehicle inspection facilities.

Transportation department employees in the general office also keep insurance records, accident reports, papers on newly purchased vehicles and the retirement of old units and maintain records on trucks coming under the jurisdiction of the Interstate Commerce Commission.

In addition to the routine records on each vehicle, comprehensive records of maintenance also are kept. Such records include Driver's Vehicle Condition Reports, Equipment Use Reports, Mechanical Inspection Cards, Memorandum of Needed Mechanical Repairs and Shop Repair Orders.

Pool Car Garage

The pool car garage in Owensboro is another important segment of Texas Gas' transportation department. Here, employees inspect, check out and equip new cars; maintain a group of pool cars for personnel who have no assigned cars; and wash, lubricate and service an almost endless stream of cars.

Employees in the pool car garage also provide a valuable transportation service for employees traveling to and from the various airports, railroad stations and bus depots in the vicinity around Owensboro.

The company's Division 1 auto shop in Greenville, Miss., performs maintenance and repair jobs on all vehicles and equipment in the areas of operation south of the Kentucky-Tennessee line and, in addition, does limited work on equipment in the area extending north from the Kentucky-Tennessee line to the termination of the company's pipeline system at Lebanon, Ohio.

The two auto maintenance shops boast the latest automotive repair equipment for complete motor testing, front system correction, mobile hydraulic cranes, lubrication, steam

Miscellaneous vehicles, like this Jeep, used in pipeline construction, receive thorough periodic overhauls. These two mechanics are completing a brake relining job.

Complete overhaul of engines is another job for Texas Gas' fully-equipped maintenance shops. Here two company mechanics and an equipment inspector examine an engine removed from one of the fleet's passenger vehicles.

cleaning, gas and electric arc welding, paint spray booth, engine reboring and wheel balancing.

Thus the two maintenance shops can perform complete overhaul jobs on any automobile, truck or unit of work equipment used by the company, and the company's skilled mechanics are proud that they are called upon to repair anything from an intricate automatic transmission to a crawler tractor or ditching machine.

Not only do the mechanics perform routine maintenance and repair jobs; they also install special equipment in vehicles and fabricate special equipment. For instance, in 1943, employees in one of the auto shops designed and built a marsh buggy that is still in use today in the marshes and swamps in the Louisiana Division.

Thus to the transportation department falls the prodigious task of maintaining and repairing literally hundreds of vehicles and units of work equipment each year.

Inspection Program

Inspections are made by the equipment inspector assigned to each division. Following a set schedule each month, the inspector and a mechanic make their rounds of company installations and check each car, truck and unit of work equipment. This monthly check consists of the inspection of the vehicle's cooling, electrical and lighting systems, steering mechanism, brakes and vehicle and safety equipment. If necessary, minor repairs or adjustments are made on the spot.

At the end of each 8000 miles, cars and trucks also undergo a complete inspection at field location or in the division auto shop. Equipment inspectors check 53 specific items.

The department depends on these monthly and 8000-mile preventive maintenance checks to expose any needed repairs to automobiles and trucks; therefore, it does not maintain a calendar or mileage overhaul program for this highway type equipment.

When either of the above inspections reveals the need for major repairs, the unit is sent to the shop at the earliest opportune time. While the unit is in the shop, other needed repairs are made — repairs that might otherwise have been delayed until the component was more nearly worn out.

When a vehicle is found to be in need of minor repairs, mechanics are dispatched to repair the unit. In this case, mechanics perform similar repair jobs on other units in the area. There have been instances, however, in which needed repairs did not economically justify sending a mechanic to the job due to the distance from the shop. In such cases the vehicle was taken to one of the local garages for repairs.

Whenever possible, the company's mechanics perform major repair jobs in the auto shops. However, they often have been called upon to repair heavy tractors, draglines or other pieces of heavy equipment out on the pipeline right-of-way under adverse weather and surface conditions.

Draglines, crawler tractors, trenchers, shovels, wheeled tractors, and power mowers are overhauled each year during the winter months when such equipment normally is idle. When a unit of work equipment is brought in to division auto shops for winter overhaul, it is disassembled and rebuilt from the floor up. On a crawler tractor, for example, such an overhaul includes the reconditioning of the track rails, idlers, sprockets and rollers, engine, fuel injection system, transmission, clutch, brake assembly, hydraulic system, etc.

Such a procedure eliminates, as nearly as possible, the need for removing the equipment from service for repairs during busier work periods.

Welding machines, air compressors, portable electric generators, water pumps, drilling machines and other work equipment are overhauled when such major repairs are required.

Texas Gas feels that through its monthly preventive maintenance inspections and the 8000-mile inspections, many costly mechanical failures are prevented — mechanical failures that might have caused collisions and the possible loss of life. The company feels, too, that if through its preventive maintenance program it can save one life, the cost of the program is well justified.

About the Author

M. W. Beech, superintendent of the transportation department for Texas Gas Transmission Corporation, Owensboro, Ky., is a 31-year veteran in the natural gas industry. He has been an employee of Texas Gas since April, 1930, when he joined the pipeline department of a predecessor company, Memphis Natural Gas Company in Memphis, Tenn. Later he transferred to that company's transportation department and in June, 1935, was named foreman, serving in this capacity until promoted to superintendent in January, 1940. In 1949, Beech was transferred to Texas Gas' general office in Owensboro.

■

NGPL Solves Engine Lubrication

A unique system of efficient engine lubrication at field booster and main line compressor stations has solved a perennial problem for Natural Gas Pipeline Company of America.

Employees no longer work part of each shift with measuring cans and grease guns to supply the average 25 quarts of oil daily to each engine. Instead, a constant flow of lubricating oil is automatically delivered to each engineer's power and compressor cylinders, as well as crankcase, in the manner shown in the accompanying diagram.

The continuous freshening of crankcase oil with the addition of new oil has eliminated oil changes and reduced the need for filter cartridge replacement.

With the process now used, oil is piped from storage tanks to crankcase or lube oil tanks and to lubricator boxes mounted on the engine. It is kept at a constant level in the lubricator boxes by carburetor-like floats. From the lubricator boxes the oil is pumped to compressor and power cylinders at regular intervals. Metering devices measure the exact amount of oil consumed. Excess oil from bearings drips into the crankcase where it is mixed with fresh oil from the storage tanks and recirculated.

A similar system for lubricating engine bearings and valve mechanisms has been developed and is being installed at all horizontal-type compressor stations from 101 at Hooker, Oklahoma, through 110 at Geneseo, Illinois, as well as at Fritch, Texas, (111) and Stinnett, Texas (112).

The system lubricates engine bearings and valve mechanisms that previously had to be greased and oiled by hand. Oil is pumped from a lubricator box to each bearing through a network of flexible nylon tubes connected to lubricating points. Metering devices regulate oil flow according to each bearing's need. There are 277 bearings on the 1930 engines and 245 on the 1947 models.

Initial tests indicate the system will reduce wear on parts. Installation at all stations is expected to be completed this year.

■

Engine lubricator box with attached pumps receives spot check from Robert Vermeire, oiler-repairman at Geneseo station. Lubricating oil stored in box is pumped to engine parts, a drop at a time, through attached nylon tubing.

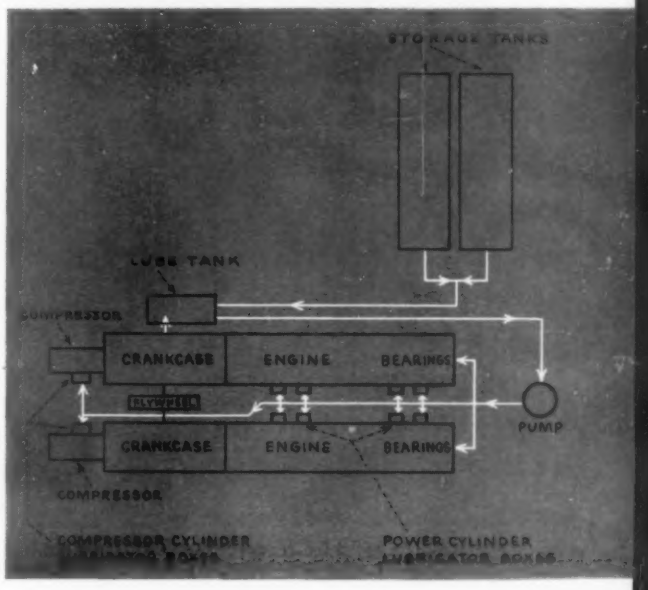
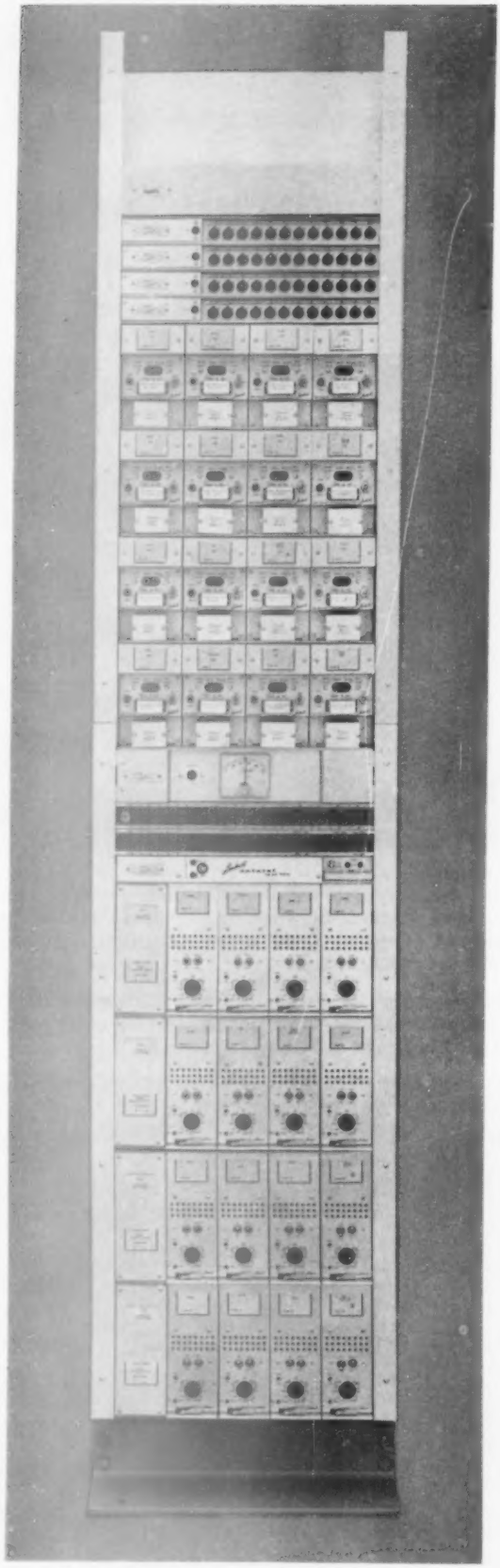


Diagram showing how lubricating oil is piped from storage tanks to power and compressor cylinders, engine bearings and valve mechanisms.



Type 23A Datatel terminal shown in typical 16-channel assembly.

Plan Ahead for

A company's communications system must be engineered to meet ultimate requirements — not just short-range objectives. Only if all facets are considered during the earliest stages of planning can a complete communications service be given.

Since more and more information ultimately will be transmitted at faster and faster speeds, there are many factors to be considered other than just the technical or the price tag on a piece of equipment. Therefore, qualified guidance in the early planning and engineering stages is most important.

Various supplier and consulting groups should be evaluated to ascertain their qualifications for doing a complete job. A company with the engineering and management ability to bring together the resources of several companies can accomplish the desired result. The experienced group knows that a total job takes teamwork on the part of several suppliers just to furnish the equipment itself. This may not produce the cheapest initial price, but it may prove to be far more economical in the long run.

E F & I

"Engineer, Furnish and Install" is a type of service several highly reputable suppliers have undertaken with varying degrees of success, along with their regular sales activities. Some are concerned only with their particular product line and the few auxiliary items of hardware that may be needed to complete an installation. Some do not maintain a full time staff of field engineers, installation supervisors or installers. Some depend almost entirely on "farming out" the greater portion of the installation, lineup and testing to local telephone workers and radio servicemen working on a part-time basis.

A most important part of any EF&I service is capable engineering assistance during the planning stages. In some cases this can be provided by the sales engineering staff of the supplier.

For some of the more elaborate systems it is advisable to have the sales engineer obtain spe-

by B. L. Arnold

Communications

cialized staff engineering assistance when laying out a system, even to bringing in technical representatives from other suppliers whose products may be required.

The engineering and planning should not necessarily be based on using the "very latest" type equipment. There are many occasions when the time-proven and well-tested methods and equipments will actually be more satisfactory, both from an economy and service reliability standpoint.

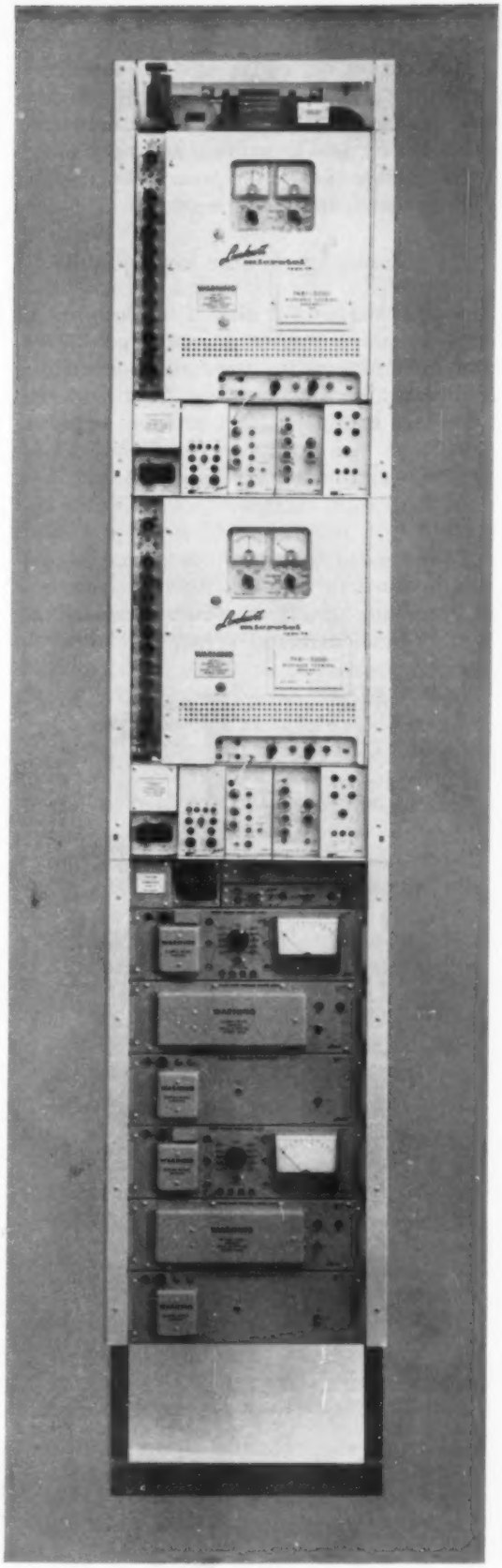
Field technicians must be fully equipped with suitable test equipment and trained in its use in order to assure proper lineup and test of any equipment being installed. This should include all noise and intermodulation tests. A communications system intended for future expansion may provide superb performance with today's light load, but have great difficulty meeting the performance specifications when handling tomorrow's heavy load.

When a microwave system is installed and tested, the transmitter should be operated at the maximum frequency deviation required by the ultimate number of channels it will be expected to handle. On some types of equipment, this test may call for special engineering assistance from the equipment manufacturer.

It should be the prime contracting supplier's responsibility to see that all equipment furnished meets the ultimate requirements of the system — not just the short-range objectives.

There are many types of equipment offered today, some designed with a specific application in mind, and some intended to be more or less universal in application.

Equipment designed for a specific job usually will give excellent performance in the application for which it was planned. However, it may be somewhat limited in its usefulness and rather inflexible when used on long systems with intermediate offices or locations requiring a mixture of different types of service. Standardized levels, impedances and overall performance characteristics should be maintained to accommodate



Type 74B Microtel terminal arranged for hot standby operation.

the greatest choice of connecting equipments and special services.

A microwave or radio system should be planned on the basis of at least a 10-year expansion program. A conservative frequency plan should be used to prevent future interference and allow maximum growth before any major rearrangements are necessary.

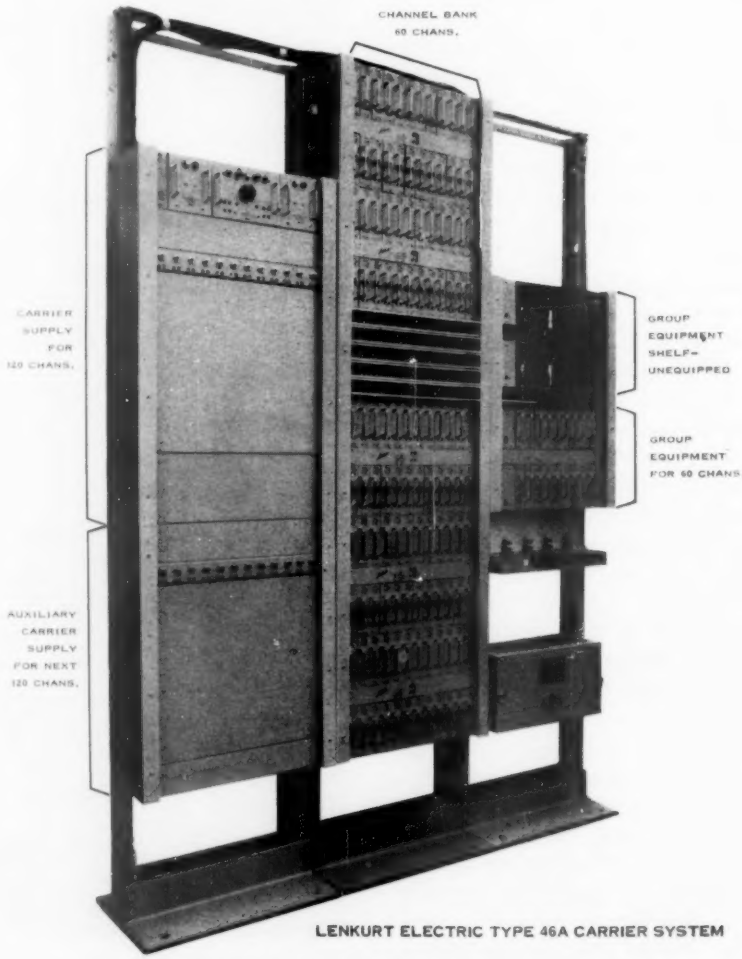
Microwave or Radio Equipment

The equipment itself should be designed as nearly as possible for the general type of service intended. This is not the same as designing just for one job and no other. Skillful design can produce equipment that provides optimum performance in a certain field of communications and is extremely versatile within the field, rather than being a "jack-of-all-trades, master of none."

A good way of telling whether equipment is really designed for a given job is to note how many applique panels or accessories must be tacked on to adapt it to the job. Special amplifiers should not be necessary to do normal jobs such as dropping or inserting channels at branching points in the system. Bandwidth far in excess of system needs hurts noise performance, reduces available gain, and reveals that the equipment may have been intended for other service.

In the industrial fields where "hot standby" operation is more commonly used, it is mandatory today that switching time be kept to an absolute minimum. This has been accomplished on certain types of equipment, in that no interruption of service is caused by switching due to fading or other atmospheric disturbance. The only switching that will be seen by the carrier equipment is a failure of the transmitter power output or the transmitter pilot and this will cause only a transmitter switch.

Wide bandwidth has been highly touted as an extremely desirable feature of a microwave system. This is a badly misused sales gimmick, because bandwidth alone is not the real determining factor as to how good a piece of equipment is or a measure of how many channels


CHANNEL BANK
60 CHANS.
CARRIER SUPPLY FOR 120 CHANS.
GROUP EQUIPMENT SHELF— UNEQUIPPED
GROUP EQUIPMENT FOR 60 CHANS.
AUXILIARY CARRIER SUPPLY FOR NEXT 120 CHANS.
LENKURT ELECTRIC TYPE 46A CARRIER SYSTEM

Lenkurt electric type 46a carrier system.

and how much data it will handle. Wide bandwidth alone has little merit unless the equipment is also capable of meeting the noise, intermodulation and overall transmission characteristics required by the multiplex or data load claimed for the system.

It is recommended that national and international standards be used as part of the acceptance tests in evaluating the equipment or a system.

Multiplex or Channelizing Equipment

There are many types of radio, cable or wireline multiplex equipment, and each has its advantages and disadvantages in certain applications. Each has certain peculiarities that may or may not limit its ability to be mixed with other types of equipment over a common transmission medium. Usually, when the transmission equipment and the multiplex equipment are manufactured by the same company, they will be compatible.

The multiplex field is complex and loaded with optional equipment and equipment features. Many of these are of value to one company, but to others are just an added expense that may never be used. Each application should be evaluated during the early engineering stages to determine which features are required and which type of equipment will meet ultimate needs of the particular company.

Degree of standardization used in the manufacture of the equipment is of utmost importance. Unless it is clearly understood that a project is experimental, an engineer should not consider untried techniques, especially when reliability is required. Consideration should be given to expandability of the equipment without interruption to working facilities. As all electronic equipment is subject to failure at one time or another, replacements service and spare parts should be readily available.

Only top quality, properly rated components should be used for trouble-free service. All units or subassemblies containing active components (amplifiers and the like) which are common to 12 or more channels should have parallel or alternate active circuitry.

Several new techniques recently have been incorporated into the fundamental design of the established reliable multiplex systems to provide even more reliable, high quality service. When the number of circuits needed justifies the initial investment for common equipment required for this newer arrangement of equipment, the annual charges for these newer type equipments usually will be less than for older designs. Use of transistors and other solid-state devices improves reliability, eliminates tube replacement and reduces space and power requirements.

There are, of course, advantages and disadvantages to both old and new designs. The engineer should not get himself so far biased toward one of the other type that he cannot make a true evaluation as to which would be best for the particular project.

A communication system today would not be considered complete if someone did not throw in the requirement for high speed data or telegraph.

What is "high speed" data in the eyes of the customer today? This is a question that cannot be answered with a flat statement applicable to every project.

There are some areas where radio and microwave are used, but manual telegraph still holds sway, while in other areas high speed data and some forms of facsimile are operated over physical pairs. Therefore, it is extremely hard to predict what constitutes "data."

There are several manufacturers who have excellent data, telegraph or telemetering equipment, and each has its peculiarities. Therefore, it is necessary to first analyze just what kind, how much, and at what speed the information must be transmitted before a proper decision can be made as to what equipment to use.

Here again, it is usually better to get a total package from one supplier who will assume performance responsibility on an overall system basis, rather than to piece together a compromise system and have to live with it.

None of us can be absolutely certain of the ultimate types of service a system may be called upon to perform. Therefore, it should be looked upon as a continuing project that will have changes, additions, and deletions as we progress.

About the Author

B. L. Arnold had 18 years' experience in the communications and electrical fields before joining the staff of Lenkurt Electric Company, Inc., six years ago. Central office and plant engineering experience was gained over a period of 13 years with General Telephone Company of California and California Interstate Telegraph Company. For five years he was division sales manager for the Carrier and Radio Division of Automatic Electric Sales Corporation. His six years with Lenkurt have been as a project engineer and in handling special project sales.

Based on a paper presented before Petroleum Industry Electrical Association, Galveston, Texas, under the title "Complete Communication Service."

■

by C. H. Klohn

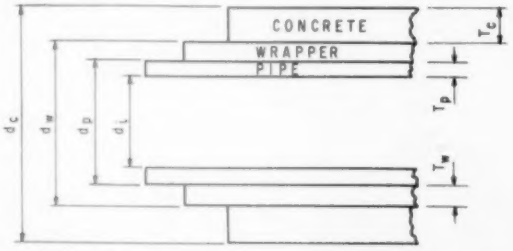
How to Design Weight

The computer effectively builds engineering tables, Tennessee Gas Pipeline Company finds.

The computer calculates a table in minutes, while other methods would take many man-hours, and gives every consideration to economical design.

One such table determines the thickness of concrete coating to apply to pipe laid in marshes and under bodies of water. Since, under these conditions, larger pipe floats, and is exposed, some heavy material is applied to weight it. An envelope of concrete of uniform thickness, which may be applied by placing or spraying, is one way of weighting the pipe. Tennessee engineers use the computer to determine its most economical design.

The equation to calculate the concrete thickness is a simple one and was derived as follows:



Steel area × density + wrapper area × density + concrete area × density = total area × environmental density × negative buoyancy factor

$$\frac{\frac{\pi}{4}(d_p^2 - d_i^2)\,W_s}{144} + \frac{\frac{\pi}{4}(d_w^2 - d_p^2)\,W_w}{144} + \frac{\frac{\pi}{4}(d_c^2 - d_w^2)\,W_c}{144} = \frac{\frac{\pi}{4}(d_c^2 W_E F)}{144}$$

This reduces to:

$$T_c = \frac{\left[\dfrac{d_p^2(W_s - W_w) - (d_p - 2T_p)^2 W_s + (d_p + 2T_w)^2 (W_w - W_c)}{W_E F - W_c}\right]^{\frac{1}{2}} - (d_p + 2T_w)}{2}$$

Where: W = density of steel, lb per cu ft
W_w = density of corrosion control coating and wrapper, lb per cu ft
W_c = density of concrete, lb per cu ft
W_E = density of environment, lb per cu ft
F = negative buoyancy factor desired (i.e. 1.20 means 1.2 times as dense as environment)
(Other nomenclatures shown in diagram)

The economies and practicality of various density weight coatings become readily apparent when looking at the accompanying table for 20-in. pipe of various wall thicknesses and three weight coating densities in an environment of fresh water. Study the table for 20-in. OD by .250-in. WT pipe for the three concrete densities. The interesting point is that, using the denser aggregates, less total weight of concrete is required, resulting in an opportunity for possible savings in transportation charges. Less volume of concrete is required also, and if the cement ratios are equal, it offers opportunity for savings in the purchase of cement.

Notice the heavier wall thicknesses, however. If we assume an arbitrary 1.5-in. minimum thickness for shell strength, we must rule out the heavier aggregates, and selection of one of the different methods of constructing this shell may depend upon the thickness required.

C. H. KLOHN is senior engineer, Tennessee Gas Pipeline Company

Coating with Computer

Table 1. Weights and Densities in an Environment of Fresh Water.

O.D. pipe	Wall thickness	Negative buoyancy	Concrete density	Concrete thickness	Maximum density	Total weight	Submerged weight	Concrete weight
20.000	0.250	1.20	140	3.202	74.880	292.864	48.811	230.563
20.000	0.281	1.20	140	3.031	74.880	285.446	47.574	216.692
20.000	0.312	1.20	140	2.859	74.880	278.050	46.342	202.865
20.000	0.344	1.20	140	2.679	74.880	270.441	45.074	188.639
20.000	0.375	1.20	140	2.503	74.880	263.094	43.849	174.902
20.000	0.406	1.20	140	2.325	74.880	255.770	42.628	161.209
20.000	0.438	1.20	140	2.139	74.880	248.235	41.373	147.121
20.000	0.469	1.20	140	1.957	74.880	240.960	40.160	133.518
20.000	0.500	1.20	140	1.773	74.880	233.708	38.951	119.960
20.000	0.531	1.20	140	1.587	74.880	226.479	37.747	106.445
20.000	0.562	1.20	140	1.398	74.880	219.274	36.546	92.975
20.000	0.594	1.20	140	1.201	74.880	211.862	35.310	79.116
20.000	0.625	1.20	140	1.007	74.880	204.705	34.118	65.735
20.000	0.656	1.20	140	.810	74.880	197.572	32.929	52.399
20.000	0.687	1.20	140	.610	74.880	190.463	31.744	39.107
20.000	0.719	1.20	140	.401	74.880	183.149	30.525	25.432
20.000	0.281	1.20	165	2.264	74.880	253.294	42.216	184.541
20.000	0.312	1.20	165	2.132	74.880	247.950	41.325	172.766
20.000	0.344	1.20	165	1.995	74.880	242.452	40.409	160.650
20.000	0.375	1.20	165	1.861	74.880	237.143	39.524	148.951
20.000	0.406	1.20	165	1.726	74.880	231.851	38.642	137.290
20.000	0.438	1.20	165	1.585	74.880	226.406	37.734	125.293
20.000	0.469	1.20	165	1.447	74.880	221.149	36.858	113.708
20.000	0.500	1.20	165	1.309	74.880	215.909	35.985	102.161
20.000	0.531	1.20	165	1.169	74.880	210.686	35.114	90.651
20.000	0.562	1.20	165	1.028	74.880	205.479	34.247	79.180
20.000	0.594	1.20	165	.881	74.880	200.123	33.354	67.377
20.000	0.625	1.20	165	.737	74.880	194.952	32.492	55.982
20.000	0.656	1.20	165	.591	74.880	189.798	31.633	44.624
20.000	0.687	1.20	165	.444	74.880	184.660	30.777	33.304
20.000	0.719	1.20	165	.291	74.880	179.375	29.896	21.658
20.000	0.281	1.20	190	1.809	74.880	235.107	39.185	166.354
20.000	0.312	1.20	190	1.702	74.880	230.924	38.487	155.739
20.000	0.344	1.20	190	1.591	74.880	226.620	37.770	144.817
20.000	0.375	1.20	190	1.482	74.880	222.463	37.077	134.272
20.000	0.406	1.20	190	1.373	74.880	218.321	36.387	123.760
20.000	0.438	1.20	190	1.259	74.880	214.058	35.676	112.945
20.000	0.469	1.20	190	1.149	74.880	209.943	34.990	102.502
20.000	0.500	1.20	190	1.038	74.880	205.840	34.307	92.093
20.000	0.531	1.20	190	.926	74.880	201.752	33.625	81.717
20.000	0.562	1.20	190	.813	74.880	197.676	32.946	71.376
20.000	0.594	1.20	190	.695	74.880	193.483	32.247	60.737
20.000	0.625	1.20	190	.581	74.880	189.435	31.572	50.465
20.000	0.656	1.20	190	.466	74.880	185.400	30.900	40.226
20.000	0.687	1.20	190	.349	74.880	181.378	30.230	30.022
20.000	0.719	1.20	190	.229	74.880	177.241	29.540	19.524

Part 8: Telemetering

by Max T. Nigh

Approximately 80% of the total telemetering systems installed today are digital telemetering systems. Ten years ago, in excess of 80% of the systems were totally analog.

Economical justifications are found in Fig. 27, which shows typical channel requirements for two pipeline stations possessing telemetering and remote control.

There are two channels for supervisory control and four channels for telemetering four data quantities from each station. This many channels would necessitate leasing of a voice channel at a cost of $300 per mile per month, or $7200 per year. In this situation, an additional investment in tone generating and receiving equipment would be required at a cost of approximately $5500.

This same job could be accomplished with a digital telemetering system employing a half-duplex telegraph channel at a cost of only 75¢ per mile per month or $1800 per year and no investment in tone equipment.

This comparison shows an operational savings of at least $5400 per year.

Definition of Analog

In parts 3 and 4, analog telemetering was explained as the conversion of a measurement into a proportional time duration signal. This

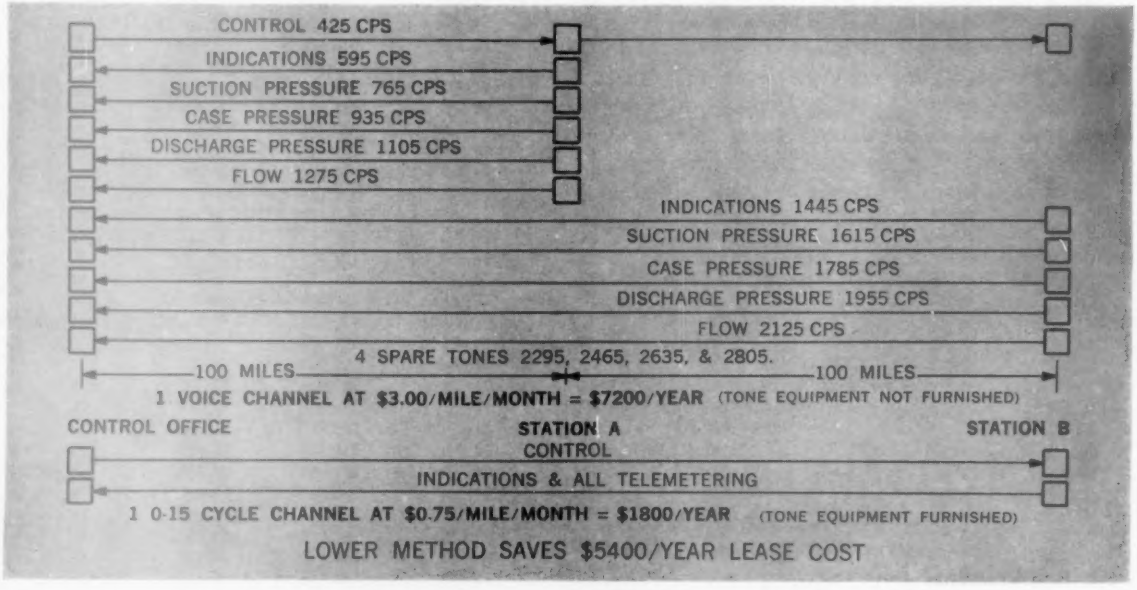

CONTROL 425 CPS
INDICATIONS 595 CPS
SUCTION PRESSURE 765 CPS
CASE PRESSURE 935 CPS
DISCHARGE PRESSURE 1105 CPS
FLOW 1275 CPS
INDICATIONS 1445 CPS
SUCTION PRESSURE 1615 CPS
CASE PRESSURE 1785 CPS
DISCHARGE PRESSURE 1955 CPS
FLOW 2125 CPS
4 SPARE TONES 2295, 2465, 2635, & 2805.
100 MILES
100 MILES
1 VOICE CHANNEL AT $3.00/MILE/MONTH = $7200/YEAR (TONE EQUIPMENT NOT FURNISHED)
CONTROL OFFICE
STATION A
STATION B
CONTROL
INDICATIONS & ALL TELEMETERING
1 0-15 CYCLE CHANNEL AT $0.75/MILE/MONTH = $1800/YEAR (TONE EQUIPMENT FURNISHED)
LOWER METHOD SAVES $5400/YEAR LEASE COST

FIG. 27. Comparison of digital vs analog on communication channel space requirement.

constrained definition of analog can be expanded to cover all industrial measurements and establish a concept of what all instrumentation transducers accomplish.

These transducers are transforming devices. They transform some range of energy to a proportional energy change of another type. Usually this is a change of natural pressure into mechanical displacement proportional to the energy change being measured. Other proportional transformations are made from mechanical displacement to obtain proportional electrical or pneumatic signals. The key term here is the word proportional.

Accuracy and Resolution

Common analog transducers in every day use are the meat scale or slide rule. In the case of a slide rule, we are converting mechanical displacement into numbers by reading the digits off the rule. We can read the slide rule to approximately three digits. We can refer then to the slide rule possessing three-digit resolution, resolution being defined as the smallest increment which can be detected or observed by a transducer.

In instrumentation, resolution is expressed as a percentage of the full-scale of the transducer.

Accuracy of transducers is a term describing how close the transducer recreates true value. Most analog transducers have an accuracy of between ½ of 1% and ¼ of 1%, full scale, which is equivalent to one part in 200 and one part in 400, respectively. Accuracy and resolution are terms which should not be confused. They are often loosely used, however, and this calls for caution when transducers are described.

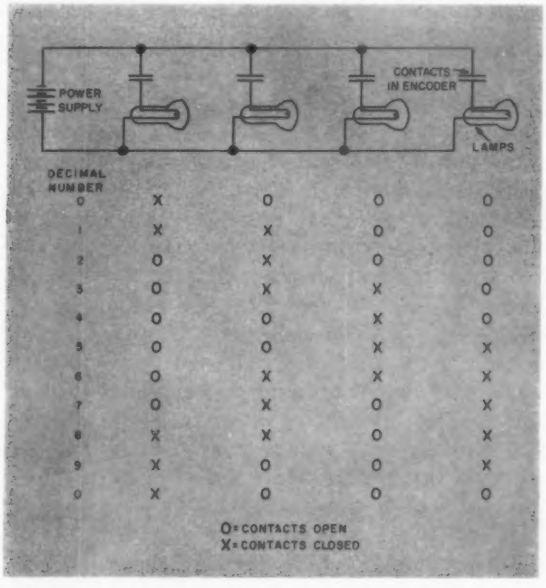


FIG. 28. A binary decimal code unique in that only one contact changes status when moving from one decimal number to the next.

Resolving these analog signals into digital quantities is done accurately to two digits, and it is common practice to express them in three digits. Three decimal digits resolution would imply ability to resolve analog measurements to one part in 1000. Since this is considerably better than the accuracy of most analog measurements, conversion of analog quantities into digital quantities in most industrial measurements need not be greater than three digits.

Information Theory

In information theory as developed by Shannon of Bell Laboratories, a transducer is defined as a linear filter which transforms information from one form to another without loss of information in the transformation. This is true of all transducers used in industry within the limitations of the transducer's frequency response.

The principle of a transducer having no loss of information from input to output is known intuitively by instrumentation people for years. The conversion or transformation from analog signals to digital signals follow this same principle, i. e. there is no loss of information in the transformation. It may be extremely difficult to extract the information from the transformed signal, but it is there nonetheless.

The important distinction between theory and practice in analog signal transformation is that in practice there is a degeneration of accuracy and possible resolution with each analog transformation. *Repeated analog transformation is thus undesirable and is to be avoided.* Once the conversion is made from analog to digital, repeated transformations in digital form do not lose accuracy, or resolution, independent of the number of transformations. This is the fundamental advantage of digital systems over analog computing systems and accounts for the great success in industrial applications of digital computing systems.

Decimal to Binary Decimal

To appreciate how an analog digital converter functions, we should first make a transformation with numbers, i. e. transforming decimal numbers into binary numbers. Fig. 28 shows four lamps, each connected to a power supply through a contact. Binary arithmetic permits us to characterize up to 16 decimal

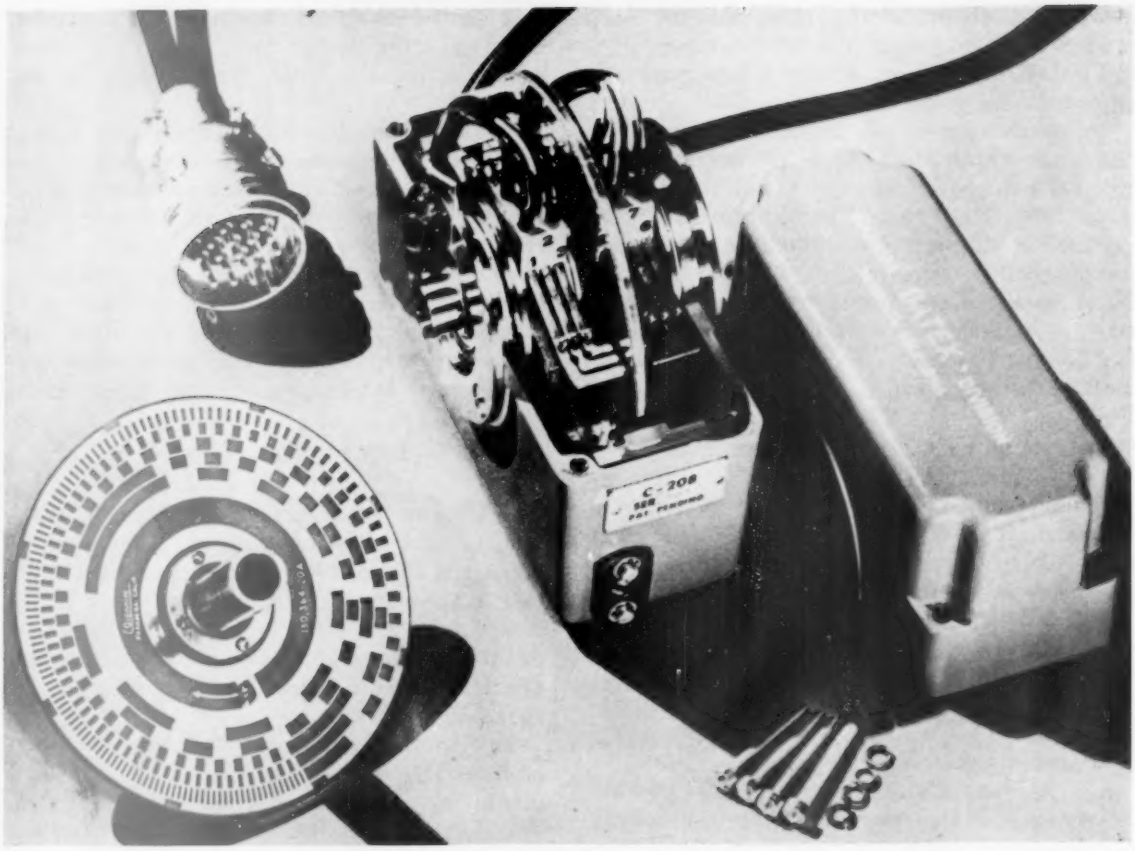


FIG. 29. Typical electromechanical analog digital converter.

numbers with four channels or the four lamps as shown.

Fig. 28 uses an X to indicate the contact is closed and O to indicate the contact is open for each individual lamp. A vertical column shows decimal numbers from 0 through 9 and the combinations of open and closed contacts for each lamp. *Note that no pattern of the four lamps is repeated from 0 through 9.*

We could characterize 16 decimal numbers, but certain liberties are taken by the engineer to add flexibility and security in the system of conversion so that normally only 9 decimal numbers are used with each four lines of characterization. If we use the present set to characterize decimal numbers from 0 to 9, we can use another set of four lamps to characterize the 10's digit 0 through 9 and another set of four lamps to characterize the 100's digit 0 through 9. With 12 lamps then, we can characterize any number between 0 and 999.

The lamps are used as a means of communication with the human brain through the eye. In a digital computer system, no such lamps are required but are replaced by circuit modules that are turned on and off by energy provided through contacts associated with each lamp.

The pattern shown in Fig. 28 is a binary decimal code and is unique in that only one contact changes status when moving from one decimal number to the next. This is a code pattern developed by Datex Div. of Gianini Co. and is an extremely desirable feature of electromechanical converters for conversion of a proportional shaft position into digital code.

Shaft Conversion

A typical electromechanical analog digital converter is shown in Fig. 29. This particular encoder configuration possesses resolution of one part in 999. This is very satisfactory for industrial measurements and exceeds the accuracy of most transducers used for industrial measurements. The code plate where the conversion takes place is composed of concentric rings of conducting and non-conducting segments. The conducting segments are usually plated silver with a molecular film of gold, or other rare metals, to increase conductivity.

Fixed brushes are allowed to ride on the disk. Thus, the code plate becomes a means of operating many switches or contacts, with four contacts used for each decimal digit. Since this is a three-decimal digit encoder, 12 positions and therefore 12 conducting rings are required

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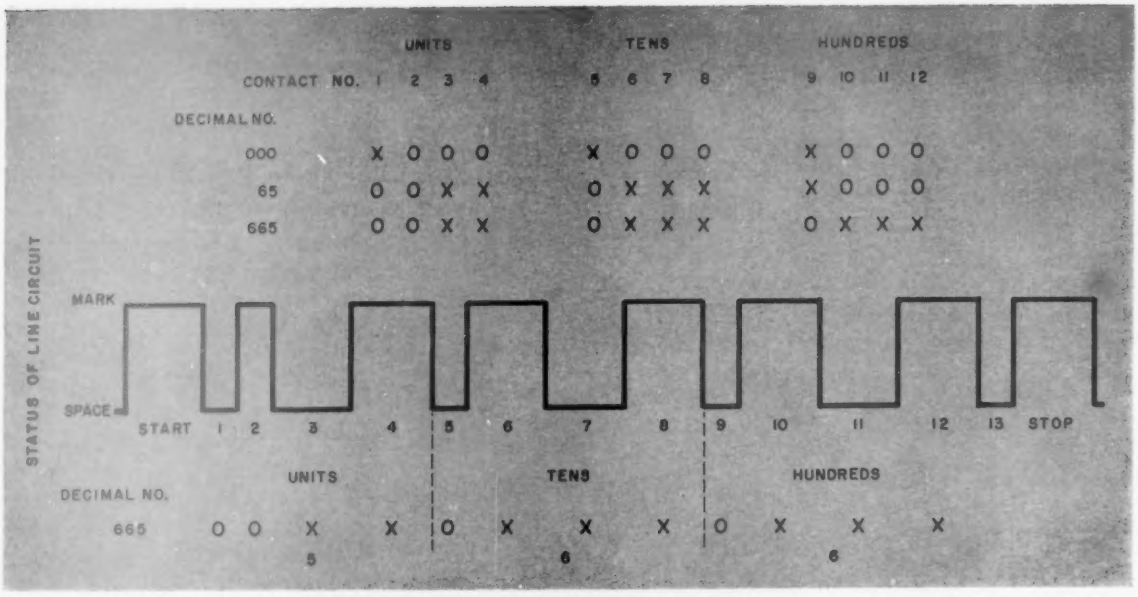

UNITS
TENS
HUNDREDS
CONTACT NO. 1 2 3 4 5 6 7 8 9 10 11 12
DECIMAL NO.
000 X O O O X O O O X O O O
65 O O X X O X X X X O O O
665 O O X X O X X X O X X X
STATUS OF LINE CIRCUIT
MARK
SPACE
START 1 2 3 4 5 6 7 8 9 10 11 12 13 STOP
UNITS
TENS
HUNDREDS
DECIMAL NO.
665 O O X X O X X X O X X X
5
6
6

FIG. 30. Decimal number to cyclic binary decimal.

with a common return from the disk conducting material. This conversion is strictly mechanical and is a most convenient manner to visualize how a conversion can be accomplished. The disk is positioned over 300 to 320 degree angular rotation proportional to the input measurement. Ideally, the input measurement would be 0 to 1000 units with the output of the converter giving 0 to 999 decimal digits.

If the range of input transducers is different from this, the pattern on the disk can be modified so that the binary decimal code produces an output of numbers varying from 0 to any other number less than 999 equivalent to the measurement. Not only can we change the conducting pattern on the disks to vary the proportional numbers it represents, we also can lay out the pattern such that mathematical relations or conversions can be made as square root, sine and cosine.

Close inspection of Fig. 29 will reveal the segments of the pattern are close together at the lower left side of the pattern and increase in width in a clockwise direction around the disk. This is a pattern for a square root disk permitting automatic conversion of a measurement to the square root of the measurement. From an engineering standpoint, it is often preferable to let the encoder range be 0 to 999, independent of the range of the input quantity and let computing equipment convert the binary decimal code output of the converter to the correct engineering figures.

Solid State Converters

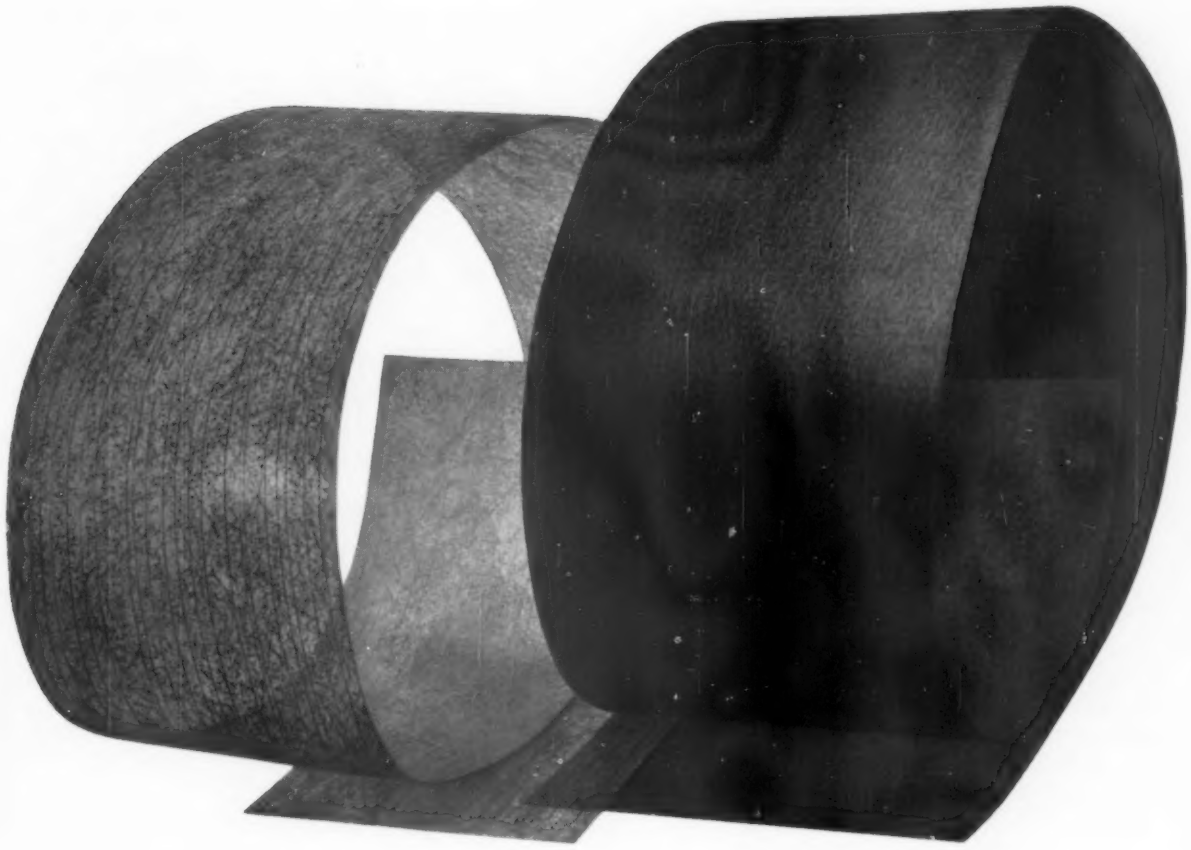
There is a complete array of electronic analog to digital converters using many different electronic design philosophies, each with its own special advantages. Since we are concerned only with concepts, these engineering details will not be discussed. What is important is that the input is a proportional analog signal and the output is in the form of energized and de-energized signal lines such as described for our typical shaft encoder. Usually 1, 2, 4, 8 BCD or binary decimal code is used.

To appreciate the conversion does not require a thorough knowledge of the engineering involved in a solid state converter. Historically, solid state analog to digital converters were first used in military applications. Over the past 10 years costs have decreased to such an extent that they are usually preferred to electromechanical analog digital converters in most applications in industry. In pipelines where very few readings are to be converted at any one location, the electromechanical shaft model is probably still the most economical conversion device. Solid state converters are constantly increasing their scope of application, and will be the preferred method as their economics improve.

In our development of digital telemetering signals, we have shown a number of patterns of transmission. By varying the status of the line in the form of mark or space, we send a message with the space representing an open contact and the mark a closed contact. Fig. 30 shows the transmission pattern for the decimal number 665 using the length of each step of the code to characterize the contact being open or closed, a short step representing an open

PROTECTION THAT

never takes a holiday!



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for enamel reinforcement

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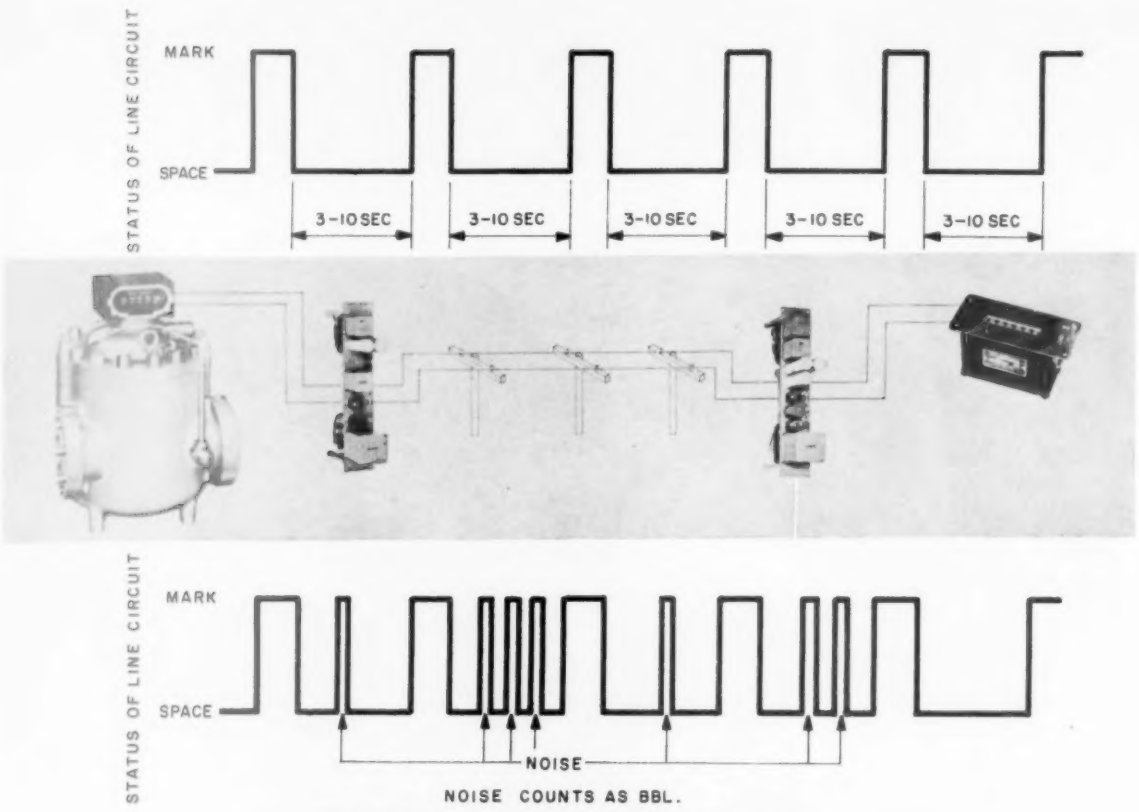

FIG. 31. Typical PD meter transmission pattern.

contact and a long step a closed contact. Twelve steps in our message allow us to characterize this three-digit number. We have not given this message an address or validity checking. These two features would be added to the message and would increase the number of steps.

Digital Instrumentation

Some measuring devices do not require conversion from analog to digital but produce a digital signal directly, such as a positive displacement meter. One commonly used technique in the pipeline industry for transmission of this digital data has been to energize a tone transmitter momentarily to represent each barrel or each 10 bbl flowing through the meter. At the receiving end, the tone receiver would pulse a digital counter to add up to the barrels flowing through the meter. Such a system is shown in Fig. 31.

The ideal pattern is shown at the top with the pulse pattern being generated for a short period some 3 to 10 sec apart. Noise could produce a similar pattern on the communication medium. A pattern similar to that shown in the bottom of Fig. 31 could result. This means additional pulses will be recorded on the counter at the receiving point. Here is a situation calling for a management decision and management appreciation of the choice between the cheapest method and the most economical method of data transmission consistent with the business policies of the company.

Economics

This system's principal advantage is economy, but this economy means that no security has been used in the transmission of this data. Consequently, false readings are not an uncommon occurrence.

To obtain security with this kind of information, it is necessary to treat it in exactly the same manner as all digital data has been treated in past discussions, i. e., it is necessary to have address, validity checking, as well as the data contained in each message. To obtain this means an investment in additional equipment at the transmitting and receiving ends.

This does not mean, however, that digital telemetering is a great deal more expensive than analog telemetering. Many messages can be sent sequentially with a digital telemetering system which would permit the same rate of information transmission as obtained with analog systems transmitting in parallel. ■

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BIG PERFORMANCE IN A COMPACT PACKAGE

H-3—43-hp gasoline engine
HD-3—40-hp diesel engine

No tractor of comparable size gives you the strength and performance advantages of this new tractor.

It has the leadership features of Allis-Chalmers big tractors—industry's toughest track, all-steel main frame, top accessibility of major components—plus heavy wrap-around grille, diesel or gasoline engine, oil-type shuttle clutch.

The shuttle clutch puts this tractor way out front in faster cycle speeds. You can shift from any of the four forward speeds to the comparable reverse speed without shifting gears.

This tractor is built to stand up to the tough requirements of construction work.

STEP UP YOUR

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These are the highlights of a continuing program to give you the most modern tractors in the industry. Your Allis-Chalmers dealer is eager to tell you about these and other improvements and to prove their value with a demonstration. You will see that Allis-Chalmers tractors are built to step up output and cut your costs.

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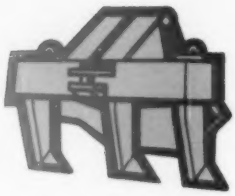
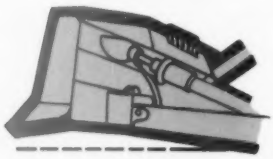


Deep penetration ripper—Allis-Chalmers unique parallelogram ripper design keeps shanks at most effective penetration angle at all depths for fast, sure ripping.



New finger-tip tilt dozer—gives you 20 inches of tilt, controlled right from the operator's seat. Compact, front-mounted, triple-valve, hydraulic unit controls blade tilt, lift and lower, and ripper lift and lower.

BETTER THAN EVER

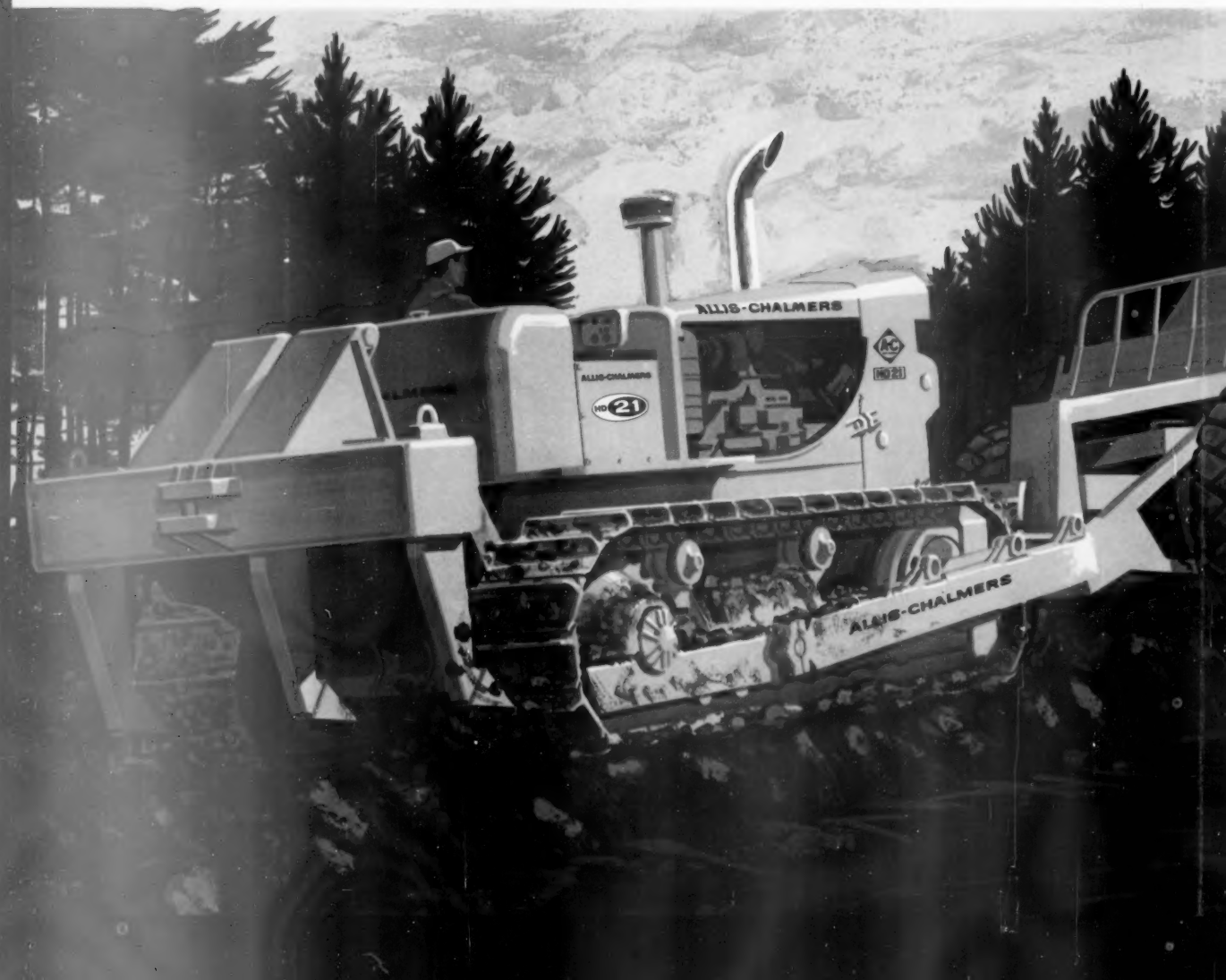
HD-21

225-hp Torque Converter Drive

Dollar for dollar, the HD-21 offers you the biggest dollar value in work capacity in the big-tractor class. Equipped with a 225-hp turbocharged engine and the most proved torque converter drive in the industry, the HD-21 gives you king-size output.

And yet, big HD-21's are practical. They're maneuverable, easy to handle, and in tandem pushing will supply more power than any single unit. If two pushers aren't needed, one can always be split off for other duty.

A complete range of front and rear-mounted attachments makes the HD-21 a match for the big jobs anywhere. It's a proved pusher . . . it's a powerful puller and ripper . . . it's a big-yardage dozer.



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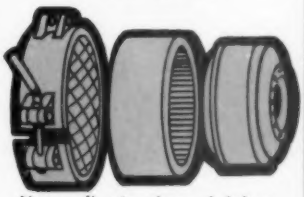


New oil steering clutches and oil-cooled power brakes on the HD-21 and HD-16 give you new standards of performance . . . new peace of mind regarding maintenance and service life. Both clutches and brakes run in a complete bath of oil so heat is dissipated with extreme efficiency giving you exceptionally long life with minimum brake adjustment . . . *no* clutch adjustment. New power steering and power brakes reduce operator effort, fatigue . . . help him maintain maximum production all day.

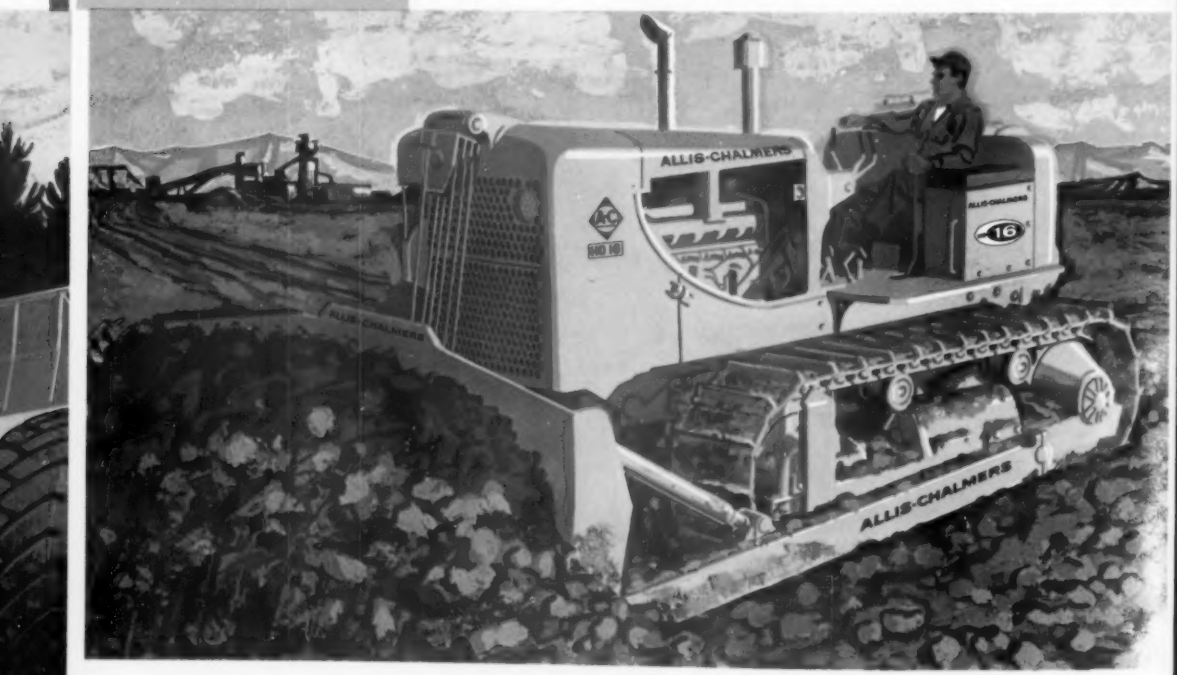
BIGGEST VALUE IN THE 150-HP CLASS

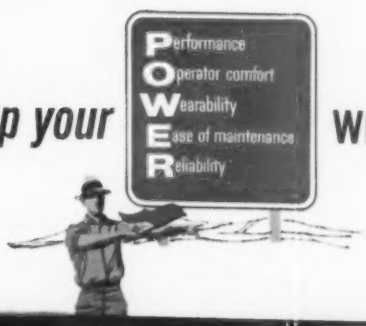
HD-16

Torque Converter or All-Gear Drive

The HD-16 continues to grow in popularity for one significant reason—big-tractor performance at medium-tractor cost. Pioneering, dozing, hauling, ripping, pushing—this tractor has a tremendous work range. It's in the same horsepower class of the biggest tractors of a few years back—yet in work output, ease of operation and maintenance, it's far and away ahead.

Here is a machine with up to 60,000 lb of drawbar pull, 19 tons of live-action dozing weight, with engines that give you up to 27 percent fuel saving over tractors with comparable-sized power packages.





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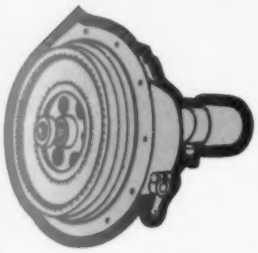

New oil master clutch is available in the HD-11 and HD-6. This Allis-Chalmers clutch is extra-heavy-duty with multiple metallic-faced plates that provide big reserve capacity for cool operation, less wear, longer life. Oil is filtered and circulated under pressure.

New finger-tip power steering—now the HD-11 brings you hydraulic power steering with the finger-tip, console-type levers so popular on the HD-21 and HD-16 models.

ANOTHER STEP AHEAD in an all-purpose size

HD-11

99-hp
All-Gear Drive
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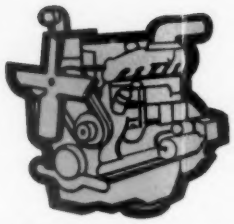
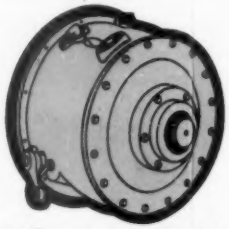
The new HD-11 gives you performance that's unmatched in its class . . . and you can also have the 1-2 punch of a powerful new engine, plus the smooth speed and efficiency of torque converter drive. The torque converter, coupled with a constant mesh transmission, three speeds forward, two reverse, gives this machine the kind of performance you would normally expect from larger machines.

In addition, you get output-boosting operator advantages like hydraulically-actuated steering clutches, and with the standard transmission machine, the easiest shift pattern in the industry.



New 10000 engine powers th HD-11. The 6000 engine is fea tured in the HD-6. Both ar fast-starting, responsive, wit high torque for top perform ance in today's tough servic They are open-chamber, con trolled-combustion engine delivering high output with out even breathing hard.



New! Torque converter drive—now Allis-Chalmers offers torque converter for the HD-1 and HD-6. On big tractors o small, you get the advantage of Allis-Chalmers torque con verter experience. Result: out standing performance and de pendability.

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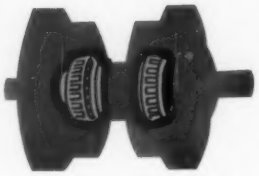
Industry's healthiest engines—give you up to 27 percent more efficient operation than ordinary engines. Unique controlled-turbulence combustion provides greater energy output on less fuel. Standard in the HD-21, HD-16, HD-11, HD-6.



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THE CLASS OF '61 —and then some

HD-6

66.5-hp All-Gear Drive 72-hp Torque Converter Drive

With the HD-6 tractor, you get advantages offered only by Allis-Chalmers in this size class.

You have a choice of three models to match the machine to your requirements:

- Power-shift transmission model with torque converter, plus power steering and power brakes.
- Standard-shift model with oil master clutch, power steering and power brakes.
- Standard-shift model with dry or oil master clutch.

In its size class—dozing, pulling, ripping—the HD-6 gives you the biggest dollar's worth in the tractor industry.

NEW HD-6

POWER-SHIFT TRANSMISSION

Allis-Chalmers has combined smooth torque converter performance with its own Power-Shift transmission incorporating a unique system of hydraulically operated, multiple-disc clutch packs. You get maximum working efficiency, accurate control with finger-tip shifting on-the-go . . . an infinite number of speeds through the entire working range (up to 5.9 mph). But that's not all!

Amazing automatic "GROUND SPEED CONTROL"

Allis-Chalmers exclusive *Ground Speed Control* system lets your operator *pre-select* and set the best working speed to match *special* conditions—slope cutting, finishing or pioneering. Now, for the first time, he has power-shift ease *plus*—broad, torque converter speed ranges, *plus*—amazing, automatic *Ground Speed Control.*

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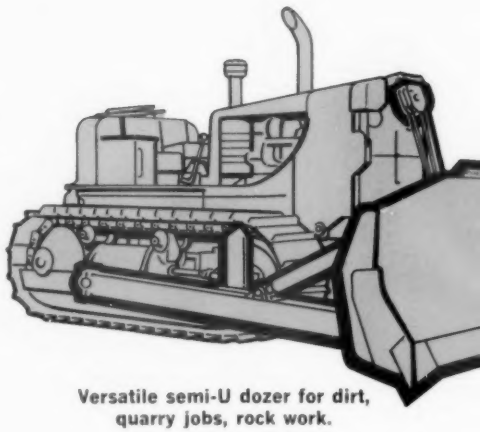
True-dimension track—specially heat-treated track shoes, side bars, track pins and bushings are in a class by themselves. Heavy-duty design of the truck frames, track guiding guards and the clean bottom construction, makes this undercarriage the best in the industry.

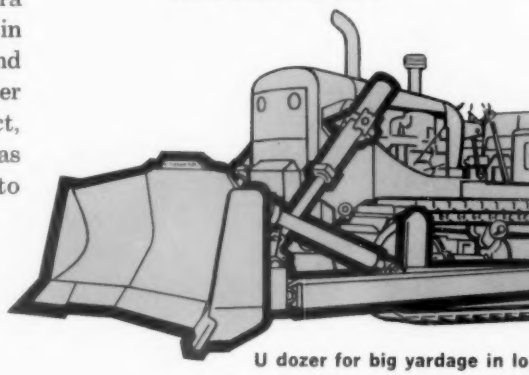
NEW, BIGGER AND STRONGER DOZ
FOR EVERY TRACTOR MODEL

You get the new U moldboard for big production in loose or semi-loose materials, and the semi-U blade for all-round dozing. Equipped with the unique rock bit, the semi-U is unequaled for rock and quarry work. You get new, straight dozers with increased height in center section for bigger capacity without sacrificing visibility.

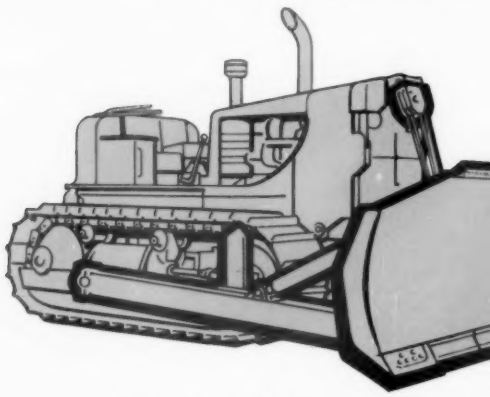
All these dozers have extra heft and strength for long life in tough duty. Cutting edges and end bits are wider and heavier for extra wear. In every respect, these dozers lead the way as Allis-Chalmers continues to step up tractor performance.



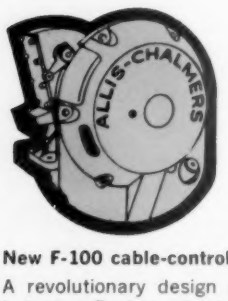
Versatile semi-U dozer for dirt, quarry jobs, rock work.



U dozer for big yardage in lo



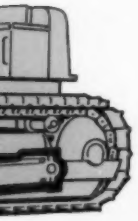
Straight dozer for all types of earth mo brush clearing, cleanup—many other j



New F-100 cable-control unit for HD-21, HD-16, HD-11 dozers

A revolutionary design concept, the F-100 cable-control unit is the only fully sealed un industry. Brakes, clutches, gears—all controls—run in a bath of oil. The F-100 seals out moisture—requires no lubrication. This cool-running, sure-acting unit has already recor standards for exceptionally long life.

ZERS



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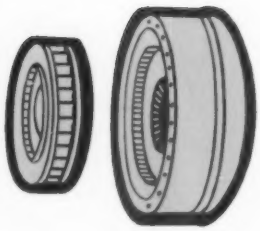
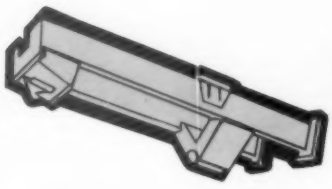
The benefits of
ALLIS-CHALMERS CONTINUING RESEARCH
extend across the entire tractor industry

Here are a few standout examples among the many developments instituted by Allis-Chalmers. First with a torque converter tractor, Allis-Chalmers pioneered a whole new concept of tractor performance with this bold departure from conventional power transmissions. Another first, extended lube intervals for truck wheels, idlers, and rollers, culminated in today's permanently lubricated units. Allis-Chalmers unit construction of major assemblies has saved untold hours of maintenance time. The main frame design idea of mounting major components to a heavy-duty, channeled frame resulted in shock-resisting, longer-lasting tractors.

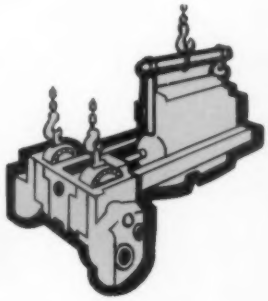


Torque converter drive

Permanent lubrication



All-steel main frame



Unit construction

AND DESIGN IMPROVEMENTS KEEP ON THE MOVE

Built into your 1961 Allis-Chalmers tractors are improvements to further boost performance, step up component life and dependability, increase operator comfort and convenience, ease the job of maintenance and service.

ALLIS-CHALMERS NEW HD-3 TRACTOR

BIG PERFORMANCE IN A COMPACT PACKAGE

H-3—43-hp gasoline engine
HD-3—40-hp diesel engine

No tractor of comparable size gives you the strength and performance advantages of this new tractor.

It has the leadership features of Allis-Chalmers big tractors—industry's toughest track, all-steel main frame, top accessibility of major components—plus heavy wrap-around grille, diesel or gasoline engine, oil-type shuttle clutch.

The shuttle clutch puts this tractor way out front in faster cycle speeds. You can shift from any of the four forward speeds to the comparable reverse speed without shifting gears.

This tractor is built to stand up to the tough requirements of construction work.

STEP UP YOUR

GET THE FULL STORY FROM YOUR ALLIS-CHALMERS DEALER

These are the highlights of a continuing program to give you the most modern tractors in the industry. Your Allis-Chalmers dealer is eager to tell you about these and other improvements and to prove their value with a demonstration. You will see that Allis-Chalmers tractors are built to step up output and cut your costs.

ALLIS-CHALMERS

POWER FOR A GROWING WORLD

ALLIS-CHALMERS, CONSTRUCTION MACHINERY DIVISION, MILWAUKEE 1, WISCONSIN, U.S.A.

Litho in U.S.A.

Step up your

CRAWLER TRACTOR

Performance
Operator comfort
Wearability
Ease of maintenance
Reliability

WITH ALLIS-CHALMERS

Analyze the crawler tractor news on the following pages and see how you get the top value to which Allis-Chalmers is committed. This is the result of project "power"—a massive Allis-Chalmers research and development program that brings you the benefits of significant product improvements.

by Frank H. Love

What Is Russia Really Doing About Gas Lines?

To discover where Russia really stands in pipeline technology, look at these interesting facts revealed in an interview with Baxter Goodrich, senior vice president of Texas Eastern Transmission Corp., who has returned from 30 days in the Soviet Union:

Dual 40-in. gas transmission lines are now under construction. The pipe, however, comes from Germany. The Russians are fabricating no pipe larger than 28 in.

About half of the members of the construction crews on these lines are women.

The Russians are triple-jointing. They claim to have mastered the process of pressure welding. They use no line-up clamps or back-up rings when making welds.

Gas is used in testing, unless a safety factor is involved.

First-class machinery and poor-grade installation are in evidence at compressor stations.

In automation, the Soviet Union is far behind the U. S.

Goodrich was the sole pipeliner in a group of eight representatives of the U. S. gas industry as part of the State Department's East-West industrial exchange program. Sponsors were the American Gas Association and State Department. A delegation from Russia's gas industry is scheduled to tour U. S. installations later.

The interview with Goodrich ranged from a discussion of Russia's seven-year plan to construction methods and quality of equipment.

Under the guidance of GLAVGAS, the state's main administrative body for the gas industry, Russia has a seven-year plan terminating in 1965, which has as its goal the laying of approximately 16,000 miles of pipelines and increasing gas production by 500%, from 1 trillion cu ft to 5 trillion cu ft per year. Part of this program has been accomplished or is underway. Accomplishments include discoveries of several gas fields and construction of pipelines.

The outstanding gas transmission system consists of dual 40-in. lines from the Uzbekistan field at Gazli to industrial centers east of the Ural Mountains. Each line will be about 1500 miles in length, a total of some 3000 miles.

The touring group was permited to observe this construction, and more will be said later about some of the methods.

Planning Group

The Soviet state planning group is known as GOSPLAN. Although the organizational chart shows GOSPLAN and GLAVGAS to be on a equal level, actually the latter is under GOSPLAN. One plans, the other constructs and operates.

Institutes are the medium through which plans and design are formulated. The Institutes are unique insofar as the U. S. industry is concerned. They constitute a concentrated technical group of people to whom specific problems are assigned by GLAVGAS. This concentration is seen as having some appealing aspects compared with U. S. pipelining, which sees individual companies doing independent work on problems common to all.

What of construction practices? On the dual 40-in. lines visited, it was observed that generally practices are similar to those of the U. S. Equipment looks strangely familiar, although trademarks are different.

The oddest appearing part of the pipeline spread is the personnel. About half of the crew

DITCH FOR TRANSMISSION, YOU'LL DIG IT BETTER WITH

BUCKEYE 407 IS LARGEST SELLING LADDER-TYPE UTILITY DITCHER

The Gar Wood-Buckeye 407 is today's most modern general utility ditcher. Its acceptance has been greater than that of *any* competitive machine. From boom tip to crawler drive, every structure, every component of the 407 is designed specifically for fast, accurate, low-cost ditching.

The 407's live hydraulic boom crowd —powerful enough to lift the machine off the ground—operates normally at only 750 psi, half the hydraulic pressure of competitive makes. A single lever controls both hoist and crowd, simplifying work around underground obstructions. The conveyor is shifted electrically by push button—the operator never has to leave his seat. And the 407's unitized construction lets you replace or service parts without major disassembly, saves money on parts and labor, materially cuts downtime. Owners report up to 18% less cost per foot of ditch with the 407, plus more profit per job and more jobs per season.

World's Largest Ditcher, Buckeye 330, Unequalled for Cross-Country Work

The mighty Gar Wood-Buckeye 330, the biggest ditcher in the world, cannot be matched for cross-country speed and operating economy. It's an investment that means extra profit year after year. It's the *only* factory-engineered ditcher designed for pipe from 30" to 48" diameter. And it digs up to 11 ft. deep and 64" wide.

The 330 features a tail-shaft governed torque converter to instantly adjust horsepower to load... dual Torq-Matic transmissions to allow maximum flexibility under all operating conditions... hydraulic wheel and conveyor hoists for operation independent of all other ditcher functions. The truss-type excavator support frame, rigidly connected to the rugged truck frame—plus the dual-rim digging wheel —stand up under the toughest of cross-country conditions.

Buckeye 403 Is Today's Most Advanced Ditcher For House Connections

For service line and house foundation ditching, for *all* small ditch contracts, nothing yet designed can beat the Gar Wood-Buckeye 403. Built especially for stop-and-go ditching, the highly maneuverable, easily transported 403 cuts a straight and accurate ditch that virtually eliminates all hand finishing. It outdigs and outlasts every type of tractor-mounted backhoe or ditcher attachment.

The compact size of the 403 gives you maximum maneuverability in tight places. Its ladder-type design lets you dig flush with walls and sidewalks. The 403's high flotation crawlers protect lawns and sidewalks from damage, carry it through areas where rubber-tired machines become hopelessly mired. For low costs and high profits, bid with the Buckeye 403. It's the "biggest" little ditcher ever built.

DISTRIBUTION, CONNECTION: A GAR WOOD–BUCKEYE!

Buckeyes First in Ditching for More Than 60 Years

Buckeye ditchers have *always* set the pace! From the invention of the first ditcher in 1893 until today, Buckeye has developed *every* major ditcher advancement . . . power by gasoline—then diesel engines, crawler mounting, invention of the ladder-type ditcher, the pipeliner, trapezoidal and farm drainage ditchers . . . these are just a few examples of Buckeye's constant leadership in ditcher engineering.

Today this experience is paying off big for pipeliners, contractors, and utility companies. The proof is in high production and low operating costs. Your Gar Wood-Buckeye dealer has that proof. Let him show you today's finest, most advanced ditchers —the Gar Wood-Buckeye line. *No matter what kind of ditch you need, there's a Buckeye that can dig it better, faster, cleaner, and at lower cost* than any other machine you can buy.

GAR WOOD-BUCKEYE 318 WORLD'S FASTEST, MOST RUGGED PIPELINER

The 318 is packed with Buckeye firsts! It's the only production ditcher equipped with a torque converter . . . the first large-capacity pipeliner compact enough to be transported on a standard low boy . . . the first with a tail-shaft governed power train. All these features, plus a hydraulic wheel hoist and conveyor drive, are *standard equipment* on the 318.

Gar Wood-Buckeye built this ditcher to handle a wide range of pipeline work faster, more efficiently, and more economically than any other ditcher ever offered. Its performance has been proved on spreads throughout the United States. With the torque converter, modern low-pressure hydraulics, and the specially designed Buckeye power train at work, the 318 keeps pipeliners well ahead of schedule and well in the black.

Buckeye 308 Is Built for Versatile Operation

Designed for cross-country pipelining, as well as gas, water and sewer lines, the Gar Wood-Buckeye 308 cuts easily through anything on your spread—caliche, coral, hardpan or rock. It combines power and ruggedness for high production with dependability for grueling day-after-day service. It gives a greater return on capital investment than any other ditcher in its class.

A hydraulic wheel hoist and conveyor drive are standard on the 308, offering completely independent operation. The tough truck frame and dual-rim digging wheel stand up in conditions too rugged for other machines. And the 308's engine operates at the torque speed best for combining greater lugging ability with lower fuel consumption. It delivers more horsepower than larger engines costing much more to operate and maintain.

GAR WOOD INDUSTRIES, INC.

Wayne, Mich. • Findlay, Ohio

is composed of women. This phenomena probably stems from the fact that so many millions of men were killed during World War II who would now be at their prime working age.

Women obviously can do anything that men can. They operate ditchers, drive trucks and tractors, weld and operate coating machines. The coating gang on the spread visited by the group is composed 90% of women, and the boss over the entire back-end operation of coating and lowering-in is a 28-year old woman . . . an engineer.

It is interesting to note that there is no target date for completion of any one project. Progress is geared to the dictum that every workman is allowed to work seven hours a day, six days a week throughout the year. If progress seems to be too rapid, work is slowed down. The dual 40-in. lines are scheduled for 1965 completion.

How the Russian's Weld

The Soviets have copied U. S. practice of yard welding, but have gone a step further. Instead of double-jointing as is done in the U. S., they triple-joint. However, the three joints add up to only about 100 ft. Wide open spaces, where practically all of their pipelines are being constructed, permit them to string this length of pipe.

The claim is made that they have mastered the process of pressure welding. But the process was demonstrated only in the laboratory. It is not being used on any work at present, although it is said to have been used on a 20-in. line.

In triple-jointing, procedure is to tack weld manually, make the hot pass with a shielded-tube weld, and the final pass with an automatic machine arc-welding under ceramic flux. In making the automatic weld, the pipe is rotated. The welding is acknowledged to be fast; however, they make one less weld to a joint than is the practice in the U. S.

Pipe coating is entirely of asphalt base. It is against the law to use a coal-tar coating. The reason given is that it is dangerous to the workmen. Thought to be more accurate is the fact that all coal-tar products are being used in chemicals. The wrap? Kraft paper only.

Another peculiarity from U. S. industry's viewpoint is the fact that no line-up clamps or back-up rings are used when making welds. The bevel is V-shaped but at a different angle.

Line testing is at 10% above the proposed working pressure of the system, except for rivers when it is 25% above.

By U. S. standards, construction progress would have to be termed slow. Normally, about 2000 ft of pipeline is laid per day. On the 40-in. it is only about half that.

Baxter Goodrich, senior vice president, Texas Eastern Transmission Corp.

Compressor Stations

In older stations reciprocating engines are used, but newer installations have centrifugal compressors driven by gas turbines or motors. The units are considerably heavier than those in the U. S. and run at slower speeds utilizing gear increasers. Gas turbines are of sizes 2000 kw (3000 hp) and 4500 kw (6429 hp) but much larger units, 6000, 9000 and 12,000 kw, are planned. The dual 40-in. lines will be equipped with motors driving centrifugal compressors and there will be 19 stations.

Contrast between well-made equipment and shoddy installation methods is quite evident at compressor stations. Piping is sloppy, buildings poorly constructed (nothing plumb or square), no safety provisions made on steps and ladders, etc. The last, and the fact that no safety hats are worn anywhere, is explained with an answer that Western visitors find amusing: accidents are against the law!

First-class machinery and poor-grade installation are thought to be the result of assigning the best mechanics to manufacturing plants and the poorer construction mechanics to installations. "But," said Mr. Goodrich, "their stations work, so maybe they are putting the emphasis where it counts most."

In automation, the Russians are far behind this country. They claim to have automation, but it is not automation to the degree the U. S. knows it. Most of it is related to the telemetering of information. Also, they can start and stop an engine remotely, but the initiation is manual, not automatic.

■

Pipeline Contractors

Alberta Consolidated Pipe Line Builders. *Alberta Gas Trunk Line Co., Ltd.* — 113 miles of 36-in. from Priddis, Alta., to a point near Rocky Mountain House, and 64 miles of 16-in. from the main line near Waterton Park gas field to the Montana border near Carway. Alberta Consolidated is a joint venture of Mannix Co., Ltd., and Piggott Construction, Ltd., both of Calgary; Banister Construction Co., Ltd., Edmonton; and Marine Pipeline and Dredging, Ltd., Vancouver.

Banister Construction Co., Ltd., 625 Northern Hardware Bldg., Edmonton, Alta., Canada.

Peace River Oil Pipe Line Co., Ltd. — 177-mile, 8 and 12-in. from Fox Creek pumping station in north central Alberta to Edmonton. Superintendent: Jack Engelking. Field office: Whitecourt.

Bristow-Hyde Engineering Corp., 2040 Tennessee Bldg., Houston 2, Tex. *Mid-America Pipeline Co.* — part of a 107-mile, 6-in. extension from Whiting to Ogden, Iowa, to serve markets in the areas of Mason City, Des Moines, Waterloo and Cedar Rapids.

Brodie Construction Co., Box 2646, Amarillo, Texas. *Northern Natural Gas Co.* — 176 miles of 2 through 8-in. in Iowa.

O. R. Burden Construction Corp., Box 5216, Tulsa, Okla. *Alamo Gas Supply Co.*—291 miles of 14 through 24-in. in southwest Texas to supply gas to San Antonio.

Dixie Pipe Line Co.—Griffin, Ga., to McBee, S.C., portion of 1100-mile, 6, 8, 10 and 12-in. LPG line.

Service Pipe Line Co. — 70 miles of 4, 6, and 8-in. near Labarge, Wyo.

Canadian Bechtel, Ltd., 25 King St., W., Toronto 1, Ont., Canada. *Western Pacific Products and Crude Oil Pipelines, Ltd.* — 145 miles of 12-in. in British Columbia from Taylor to Pine Pass.

Curran Construction, Ltd., 4532 — 5th St., N. E., Calgary, Alta., Canada. *Shell Oil Co. of Canada, Ltd.* —25 to 30 miles of gathering lines and special fabrication in the Crossfield gas field of west central Alberta. Superintendent: H. L. (Red) Tinkler. Field office: Crossfield.

Davis Construction Co., 709 N. Broadway, Cleveland, Okla. *Northern Natural Gas Co.* — 116 miles of 2 through 8-in. in Minnesota.

Dutton-Williams Bros., Ltd., North Canadian Oil Bldg., Calgary, Alta., Canada. *Alberta Gas Trunk Line Co., Ltd.* — 62 miles of 30-in. from West Cynthia to West Whitecourt, Alta., and 20-mile, 22-in. lateral from this main line to the Whitecourt field. Harland Evens is project manager.

Western Pacific Products and Crude Oil Pipelines, Ltd.—360 miles of 12-in. in British Columbia from Prince George to Kamloops, under supervision of Harland Evens and E. Maddoms.

R. H. Fulton & Co., Box 1526, Lubbock, Tex. *Continental Pipe Line Co.* — 550 miles of 2, 3, 4, 6 and 8-in. in Montana and Wyoming.

Northern Natural Gas Co. — 87 miles of 24 and 30-in. loops from near Beaver, Okla., to near Albert Lea, Minn.; 60 miles of 26-in. east of Ogden, Iowa; and 64 miles of 26-in. east of Waterloo, Iowa.

Sinclair Pipe Line Co.—170 miles of 8-in. from LaVerne to near Newalla, Okla.

Anadarko Production Co. — 83 miles of 10 and 12-in. in Kingman, Sedgwick and Butler counties, Kan.

Natural Gas Pipeline Co. of America — 27 miles of 30-in. loop in Livingston and McLean counties, Ill., and 62 miles of 36-in. loop in Meade, Clark, Ford, Republic and Cloud counties, Kan., and Mahaska County, Iowa.

Glaser Construction Co., Inc., Drawer 1387, Oil Center Station, Lafayette, La. *Trunkline Gas Co.* — 21 miles of 18-in. in Vermilion Parish, La., under supervision of Scott Peters and Louis F. Ledet.

Hall Construction Co., 1105 N. Carlton, Liberal, Kan. *Panhandle Eastern Pipe Line Co.* — a 330-mile, 4 through 12-in. gathering system in western Kansas. Supervising are Mike Bell and M. E. Banning.

Harbert Construction Corp., Drawer 75, Birmingham, Ala. *Northern Natural Gas Co.* — 138 miles of 2 through 8-in. lateral lines in Minnesota. Field office: Pine Island. Superintendent: Jay Cundiff.

Henuset Brothers, Ltd., Box 657, Virden, Man., Canada. *The Alberta Gas Trunk Line Co., Ltd.* — four laterals totaling 58 miles as follows: 6.8 miles of 16-in. from Wildcat Hills field to main line near Cochrane west of Calgary; 24.3 miles of 22-in. from East Calgary field to main line near Cochrane; 14.5 miles of 16-in. from Carstairs processing plant near Carstairs and Crossfield fields to foothills system main line west of Crossfield; and 12.5 miles of 12-in. from Minnehik-Buck Lake field to southwest of Buck Lake on foothills system main line.

Houston Contracting Co., 2807 Buffalo Speedway, Houston 6, Tex.

Texas Eastern Transmission Corp. — 161 miles of 20-in. from West Monroe, La., to Kosciusko, Miss.

Dixie Pipe Line Co. — 226 miles of 10-in. LPG from Mont Belvieu, Tex., to Baton Rouge, La.

Transcontinental Gas Pipe Line Corp. — four loops consisting of 65 miles of 30 and 36-in. from Fulshear, Tex., to New Roads, La., under the supervision of M. L. Thompson.

Texas Gas Transmission Corp. — approximately 70 miles of 26 and 30-in. loops from vicinity of Memphis, Tenn., to vicinity of Lafayette,

AUTOMATION

THROUGH COMMUNICATIONS

with 99.+% operational reliability

It's no secret along the pipeline that Lenkurt Electric traditionally exercises rigid engineering disciplines in the design of microwave and carrier equipment —and imposes unusually high *system* reliability standards on all Lenkurt engineered microwave systems.

For instance, the self-imposed reliability standard of Lenkurt microwave is 99.99% per hop, because experience has proven lower standards will cost you more in the long run.

Any pipeline company with an eye to *reliable automation through communications* can draw some interesting conclusions from this:

Where performance requirements must be high, the cost of Lenkurt equipment is the lowest.

Where life expectancy and reliability are measured in decades—as Lenkurt equipment and systems are—you always obtain the greatest returns on your original investment.

As a leading specialist in microwave and carrier, Lenkurt Electric is ready now to bring you *total* communications in one package—and handle the complete installation from start to finish.

For complete information about the advantages of dealing with Lenkurt Electric, contact the Lenkurt Electric office nearest you.

Lenkurt Electric Co., Inc., San Carlos, California. Offices in Atlanta, Chicago, Dallas, Minneapolis, New York and San Carlos.

LENKURT ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

Specialists in VIDEO, VOICE and DATA TRANSMISSION

La. Superintendent: A. J. Slovack. Assistant superintendent: L. L. Patterson. Office manager: B. C. Sweeney.

C. S. LeNoir Construction Co., Box 798, Austin, Tex. *Transcontinental Gas Pipe Line Corp.* — 83 miles of 36-in. in four loops: 21 miles in Walthall, Marion and Jefferson Davis counties, Miss; 12 miles in Choctaw County, Ala.; 32 miles in Perry and Dallas counties, Ala.; 18 miles in Autauga and Chilton counties, Ala. Headquarters: Columbia, Miss. Superintendent: W. B. Williams.

Majestic Contractors, Inc., subsidiary of Majestic Contractors, Ltd. *Montana Power Co.* — 56 miles of 16-in. from Cut Bank, Mont., headquarters, to the Canadian border near Carway, Alta.

Mannix Co., Ltd., 737 — 8 Ave., S.W., Calgary, Alta., Canada. *Alberta Gas Trunk Line Co., Ltd.* — compressor station at Princess, Alta., under the supervision of J. Hobbs.

Alberta Natural Gas Co. — on a subcontract from Price-Poole of Canada, Ltd., 20 miles of 36-in. in the Crowsnest Pass region of southwestern British Columbia. Superintendent: Otis Hare.

M-R Construction Co., Box 484, Wichita 1, Kan. *Mid-America Pipeline Co.*—part of a 107-mile, 6-in. extension from Whiting to Ogden, Iowa, to serve markets in the areas of Mason City, Des Moines, Waterloo and Cedar Rapids.

J. P. Neill and Co., Meadows Bldg., Dallas, Tex. *Pacific Gas Transmission Co.* — 468 miles of 36-in. from California-Oregon boundary to Rosalia, Wash., as joint venture with Western Pipelines, Inc. Colfax, Wash., is field office now for a 152-mile, 36-in. segment from Stanfield, Ore., to Rosalia, Wash. Jack Hays is superintendent.

Panama, Inc., 1801 Tennessee Bldg., Houston 2, Tex. *Northern Natural Gas Co.* — 82-mile, 20-in. from Menominee, Ill., to Janesville, Wis., under the supervision of A. J. McIntyre.

United Gas Pipe Line Co. — 61 miles of 30-in. in Quachita, Caldwell and LaSalle parishes, La., beginning near West Monroe and extending southerly to Louisiana Hwy. 500. Headquarters: West Monroe. Superintendent: A. J. McIntyre.

Panama-Williams Corp., 1418 Melrose Bldg., Houston, Tex. *Carolina Pipe Line Co.* — 87 miles of 8 and 10-in. from Aiken to Camden, S. C., under the supervision of Blackie Woodruff.

Natural Gas Pipe Line Co. of America — 73 miles of 30-in. loops in the areas of El Campo and Refugio, Tex., with field office at the former. W. N. Shiflett is superintendent. Also, 62 miles of 30-in. loops in the areas of Marshall and Cleveland, Tex., with field office at the former. M. E. Sutton is superintendent.

Pease Bros. Co., 120 E. Main St., Vernal, Utah. *Mountain Fuel Supply Co.* and *Utah Natural Gas Co.*—103 miles of 20-in. from the Uintah Basin to Clear Creek, Carbon County, Utah.

Pentzien, Inc., 1504 Dodge St., Omaha, Neb. *Texas Eastern Transmission Corp.* — dual crossing of Ouachita River near Monroe, La., and dual crossing of Mississippi River near Lake Providence, La.

H. C. Price Co., Price Tower, Bartlesville, Okla. *Pacific Gas & Electric Co.* — 296 miles of 36-in. to the Oregon border from the San Francisco Bay area. Superintendent; R. L. Ezell. Office manager: Bob Walker. Entire line is being Somastic coated by Price Co. pipe coating division.

Pacific Gas Transmission Co. — 146 miles of 36-in. from Rosalia, Wash., to the Idaho-British Columbia border. Superintendent: G. A. Reutzel. Office manager: E. Dickson at Veradale, Wash. Entire line being double-jointed and yard enamel coated by Price Co. pipe coating division.

El Paso Natural Gas Co. — 14.4 miles of 30-in. in Washington, beginning near Spokane and tying in with the Pacific Gas Transmission line currently under construction in that area. Superintendent: L. O. Reutzel. Field office manager: Allen Stotler at Veradale, Wash.

Rocky Mountain Natural Gas Co., Inc. — 35-mile, 4 and 6-in. gathering system and 40 miles of 6-in. transmission line—part of the Roaring Fork project — in Colorado. Headquarters: Carbondale. Superintendent: D. S. Thigpen.

Texas Eastern Transmission Corp. — 26.5 miles of 30 and 36-in. in New Jersey. Superintendent: Elwood Roth. Office manager: Nick Beffer at Flemington, N. J. Entire line also being Somastic coated by Price Co. pipe coating division.

Price-Poole of Canada, Ltd., Box 969, Cranbrook, B. C., Canada. *Alberta Natural Gas Co.* — 107 miles of 36-in. from Crowsnest Pass to the Idaho boundary at Kingsgate-Eastport. Joint venture of H. C. Price Co. of Canada, Ltd., Calgary, and Poole Construction Co., Ltd., Edmonton. C. E. Shivel is superintendent, and Wayne McKnight is office manager at Cranbrook, B. C. Entire line double jointed and yard enamel coated by Price-Poole pipe coating division.

R. E. Reutzel Co., Inc., Box 727, Fremont, Neb. *Northern Natural Gas Co.* — 116 miles of 2, 3, 4, 6 and 8-in. in South Dakota. Spreadman: James Adcock. Office manager: R. E. Whitworth.

S.A.I.P.E.M., Casella Postale 4159, Milan, Italy. *Oil India Private, Ltd.* — 720 miles of 14, 16 and 18-in. from Nahorkatiya to Barauni.

Baghdad, Iraq, Ministry of Industry — 56 miles of 10, 14 and 18-in. from Rumaila to Basrah.

SNAM (Oleodotti Internazionali) — 118 miles of 24 and 26-in. from Genoa to Ponte Tresa; 120 miles of 16 and 18-in. from Ferrera to S. Bernardo; 53 miles of 22 and 24-in. from Ponte Tresa to S. Bernardino; 90 miles of 22-in. from S. Bernardino to St. Margrethen; and 37 miles of 16-in. from S. Bernardo to Aigle. Also for SNAM, 59 miles of 18 and 20-in. from Cremona to Bologna.

Y.P.F. (Buenos Aires, Argentina) — 106 miles of 6, 8 and 10-in. in the Comodoro oil field; and 16 miles of 18-in. from Canadon Leon to Caleta Olivia.

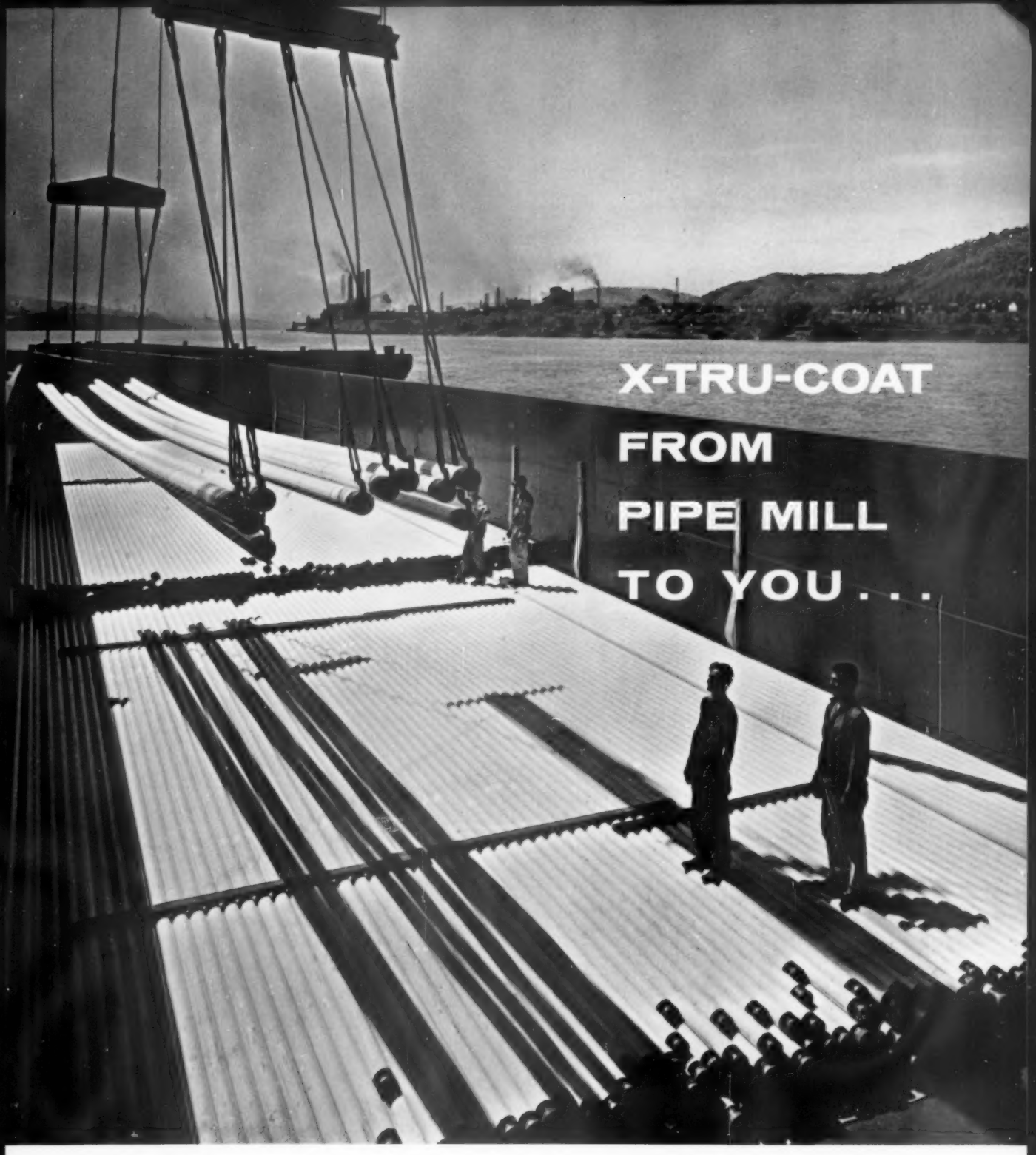
AGIP Mineraria (Milan, Italy) — 62-mile, 6 and 8-in. natural gas gathering system in the Ferrandina field.

Shamrock Construction Co., Box 1177, Lansing, Mich. *Northern Natural Gas Co.*—130 miles of 2 through 8-in. laterals in Iowa.

Shamrock Constructors, Inc., Box 505, Dodge City, Kan. *Mustang Fuel Corp.* — 77 miles of 12-in. gathering lines in Canadian, Dewey, and Blaine counties, Okla. Headquarters: El Reno.

Sharman, Allen, Gay & Taylor, Inc., Box 13152, Houston, Tex. *Dixie Pipe Line Co.* — from the Mississippi River to Demopolis, Ala. — a portion of the 1100-mile, 6, 8, 10 and 12-in. LPG line.

Trunkline Gas Co. — 35 miles of 26-in. from Cow Island to Jennings,



PROVED in 50 million feet of installations, this plastic coated steel pipe takes to the most corrosive soils. Saves you time and money. **X-TRU-COAT** is available from the pipe mill in all sizes from ½″ through 8⅝″ O.D.

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Phillips Petroleum Company, Bartlesville, Oklahoma, recently installed a 6-inch products line between their Chocolate Bayou plant and processing plants in Brazoria, Texas.

Republic X-TRU-COAT—*coated at the pipe mill*—kept this installation moving despite frequent showers and severe mud. Naturally, the only bare steel requiring field coating was the cut back area at the pipe end necessary for welding. In addition, the tough plastic coating let Brazos Construction Company, pipeline contractors, string this pipe directly on the ground, then skid it onto timbers immediately behind welding operations.

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X-TRU-COAT is immune to the most corrosive soils. It insulates against electrolytic action and takes shipping, stringing, and installation in stride. Best proof is that customers have used *more than 50,000,000 feet* of this outstanding Republic product in the past four years.

X-TRU-COAT from the pipe mill is available in ½" through 8" nominal. Users state that it can be bought and installed for *less* money than conventionally wrapped pipe. But biggest savings are in longer life. Republic X-TRU-COAT offers the highest known corrosion resistance.

Call your nearest Republic sales office for consultation or quotations. For a picture of a few of the hundreds of current X-TRU-COAT installations, mail the coupon on the following page. A free copy of the new *X-TRU-COAT Brochure* will be sent by return mail.

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Expanded Electric Fusion Weld in 24", 26", and 30" O.D. Lengths: random (approximately 30') and double random (approximately 60', mid-welded). Specs: ASTM, API. Grades: X-42, 46, 52, 56, and 60. End finish: plain end beveled, plain end square cut.

Electric Resistance Weld in 1.315" through 16" O.D. Standard, extra strong, and light wall. Black and galvanized. Lengths: single, double, ½ and ⅓ random lengths, and cut lengths. Specs: ASTM, API, U. S. Federal, etc.

X-TRU-COAT Plastic Coated Steel Pipe in ½" through 8⅝" O.D. Electric Resistance Weld and Continuous Butt Weld. Standard, extra strong and light wall. Can be applied to either black or galvanized pipe. Uniform 21' lengths, cut lengths, single and double random lengths. End finish: threaded and coupled, threaded, plain end beveled, square cut or grooved for Victaulic Couplings.

Continuous Butt Weld in ⅛" through 4". Standard and line pipe. Threaded and coupled, threaded, plain end beveled or square cut. Standard, extra strong, double extra strong. Uniform 21' lengths, cut lengths, single and double random lengths. Specs: ASTM, API, U.S. Federal, etc.

SRK® Plastic Pipe (ABS Type I, IA and II) in 20' straight lengths. 100 lb.—2" through 6"; 150 lb.—½" through 6"; standard and extra heavy IPS—½" through 8"; AGA size—½" through 6" (Subcommittee Report DMC-56-16).

SRB® Plastic Pipe (Semi-Rigid Butyrate) in 20' straight lengths. 2" through 4" in standard SWP weights.

Fe® Plastic Pipe (Flexible Polyethylene) in the following weights and sizes: standard—2" through 6", 75 and 100 lb.—½" through 2". 4" and 6" sizes in 25' straight lengths. ½" through 3" sizes in coils.

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Five W-K-M SAF-T-SEAL Gate Valves in this automated crude oil pumping station control a daily flow of 250,000 barrels of crude at 500 psi. These valves are first choice for vital jobs because of their unequalled sealing ability and extremely high reliability factor.

The SAF-T-SEAL is a non-lubricated pressure sealing gate valve—its floating steel seats with Teflon inserts give positive, total contact sealing *both upstream and down, in both open and closed position.* Its basic simplicity provides a degree of reliability greater than any other similar valve. Further, when working parts become worn, new valve performance may be quickly restored by installing new parts *while the valve is on the line.* Other features, such as automatic relief of excessive body pressure, the efficient enclosed packing gland, the effectiveness of the valves in double block and bleed service, are explained in Catalog WS 1061. Write for your copy today. W-K-M Division of ACF Industries, Inc., Box 2117, Houston, Texas.

W-K-M SAF-T-SEAL Gate Valves are available in sizes from 2 inches through 42 inches. Pressure ranges: ASA 150, ASA 300, ASA 600, ASA 900.

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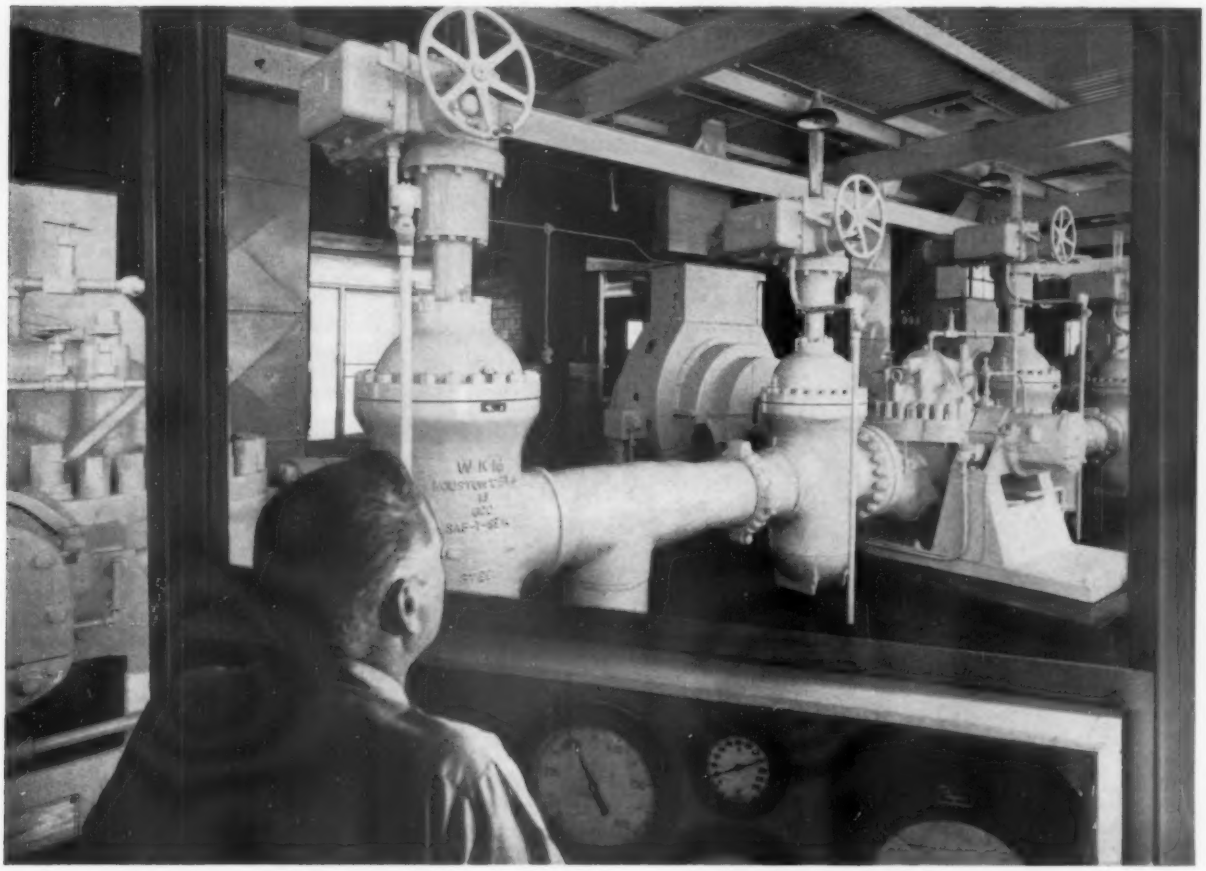

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La. Field office: Morse, La. Superintendent: T. L. Plake.

Sheehan Pipe Line Construction Co., 514 National Bank of Tulsa Bldg., Tulsa, Okla. *Transwestern Pipeline Co.* — has underway an additional 250 miles on the 4, 6, 8, 10, and 12-in. gathering system in Oklahoma and Texas.

SunOlin Chemical Co. — 50 miles of 6-in. and 30 miles of 4-in. in New Jersey from Paulsboro to Deepwater. C. M. Brown is superintendent.

Stanley-Bledsoe Corp., 612 Daniel Bldg., Tulsa 3, Okla. *Pacific Gas Transmission Co.* — double-jointing and yard-treating 466 miles of 36-in. in three schedules in Klamath, Jefferson, Umatilla and Gilliam counties, Ore., and Walla Walla and Whitman counties, Wash. Superintendent: W. D. Smith, Jr.

Dixie Pipe Line Co. — 30 miles of 8-in. and 96 miles of 6-in. from north of McBee, Chesterfield County, S.C., to south of Apex, Wake County, N.C. Headquarters: Cherau, S.C., and Sanford, N.C.

United Gas Pipe Line Co. — approximately 40 miles of 30-in., including a crossing of the Red River, from south side of the river located in Avoyelles Parish, La., northerly to LaSalle Parish. Field office: Alexandria, La. Superintendent: M. T. Wilhite.

Vaughn & Taylor Construction Co., Inc., Box 3266, Odessa, Tex. *Western Slope Gas Co.* — 110 miles of 2 through 8-in., with laterals, from Del Norte, Colo., to Antonio, with D. D. Vaughn as general superintendent. Field office: Alamosa.

Western Pipe Line, Inc., Box 1076, Austin, Tex. *Pacific Gas Transmission Co.* — 468 miles of 36-in. from California-Oregon boundary to Rosalia, Wash., as joint venture with J. P. Neill and Co., Inc. J. C. Oliver is project manager. John Wells is superintendent on 150 miles between Malin and Bend, Ore., and Ervin Simpson is superintendent on 150 miles between Bend and north of Ione, Ore.

Texas Eastern Transmission Corp. — 18-mile, 30-in. from southwest of Wilkesville, Vinton County, Ohio, to near Athens compressor station; and 12-mile, 30-in. from south of Moundsville, W. Va.. to Holbrook station near Wind Ridge, Green County, Pa.

Williams Bros. Co., National Bank of Tulsa Bldg., Tulsa, Okla. *Transcontinental Gas Pipe Line Corp.* — 76 miles of 36-in. loops in Georgia, South Carolina and North Carolina. Headquarters: Athens, Ga. Superintendent: Earl Saulsman.

Montana-Dakota Utilities Co. — 106-mile, 12-in. from Minot to Bismarck, N. D.

Texas Eastern Transmission Co. — four 30-in. loops totaling 40 miles in Pennsylvania as follows: near Ebensburg, Mt. Union, Harrisburg and Reading. Headquarters: Ebensburg. Superintendent: M. O. Thompson.

Natural Gas Pipeline Co. of America — two 30-in. loops totaling 78 miles in Arkansas — near Arkadelphia and Corning.

American Telephone & Telegraph Co. — cable-laying between Rushville, Ohio, and Williamstown, Ky., under the supervision of J. S. Martindale at Pomeroy, Ohio.

H. B. Zachry Co., Box 10188, San Antonio 21, Tex. *Dixie Pipe Line Co.* — Demopolis, Ala., to Griffin, Ga.,a 241-mile, 10 and 12-in. portion of the 1100-mile, 6, 8, 10 and 12-in. LPG line.

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Coming Construction

Propane Line Plans Finalized

Texas Eastman Co. announces that it is proceeding with construction of a 275-mile, 6-in. pipeline that will be utilized initially for transporting propane.

Brown & Root is engineering the project, completion of which is scheduled for late December.

The pipeline will extend from Texas Eastman's plant site in Harrison County, near Longview, Tex., to Phillips' salt dome storage facilities at Clemens Dome, via Texas Eastman's salt dome storage at Tyler.

First construction contracts will be for the northerly section. The remainder of the line will be constructed in two separate sections comprising about 80 miles each.

Condensate Lines Approved

Construction permits have been issued officially by the Alberta Oil and Gas Conservation Board for three condensate pipelines in southwestern and west central Alberta.

The permits were extended to: Britamoil Pipe Line Co., Ltd., for a 60-mile, 8-in. from Rimbey gas field to Edmonton; Royalite Oil Co., Ltd., for a 40-mile, 4-in. from Wildcat Hills gas plant to the Valley pipeline near Calgary; and Hudson's Bay Oil and Gas Co., Ltd., for a 50-mile, 4 and 8-in. from Waterton and Pincher Creek gas fields to the Alberta-Montana border near Carway, Alta.

Britamoil and Royalite will act on their permits promptly, but Hudson's Bay must await an export permit from the National Energy Board.

FPC Sets Transco Hearing

A Federal Power Commission hearing has been scheduled for Sept. 25 on proposed pipeline expansion by Transcontinental Gas Pipe Line Corp. and development of underground storage by New York State Natural Gas Corp.

Transco's proposal (CP 61-194) includes: 187 miles of 36-in. loops and an additional 12,500-hp in six existing main line stations; 37 miles of small diameter gathering lines, a 4000-hp compressor station and six purchase meter and regulator stations to take gas from the Ship Shoal and South Pelto areas, offshore Terrebonne Parish, La.; and a 6000-hp station for delivery of additional gas for storage and a sales meter and regulator station at Elizabethtown, N. J. Total cost of construction is estimated at $40,384,000.

The New York State proposal with which the hearing is concerned is the firm's one-half interest in further development and operation of the Leidy underground storage pool. Transco and Texas Eastern Transmission Corp., involved in the joint application (CP 61-238), already have FPC approval.

Line to Dallas Area Charted

American Petrofina has revealed plans to construct a 133-mile, 6-in. pipeline from its Mount Pleasant, Tex., refinery to its existing terminal at Grapevine in the Greater Dallas-Fort Worth area.

The $2,500,000 project also will include a terminal at Greenville, approximately 50 miles northeast of Dallas.

The new system will have a capacity of 10,000 bbl daily with an initial throughput expected to average about 6000 bbl per day.

Right-of-way work has already begun and pipe orders placed, but construction contracts have not been awarded.

To Supply Michigan Airbase

A new pipeline company has underway a 55-mile petroleum products line in Michigan's Upper Peninsula.

The National Pipe Line Co., a new affiliate of F. H. McGraw & Co., engineers and constructors, is scheduling completion of the $1,300,000 project for mid-September.

To supply the K. I. Sawyer Air Force Base near Sands, Mich., with jet fuel, the pipeline will start at Escanaba and follow The Chicago and North Western Railway right-of-way.

Clifford S. Strike, McGraw president, says it is contemplated that the line will be extended beyond the air base to service commercial petroleum users in the Marquette area.

To Bring Gas Ashore

Pacific Lighting Gas Supply Co. is seeking to have in operation by Dec. 1 a 24-mile, 16-in. pipeline to move natural gas from offshore wells in the Gaviota area.

The company expects construction on the $1,740,000 line to start about Sept. 1, pending approval from the California Public Utilities Commission.

The proposed transmission artery would move gas produced by Standard Oil Co. of California, Phillips Petroleum Co. and Texaco, Inc., to Goleta, Santa Barbara County, where it would go either into PLGS' underground storage field or be delivered to its distribution affiliates, Southern California and Southern Counties Gas companies.

Internationally...

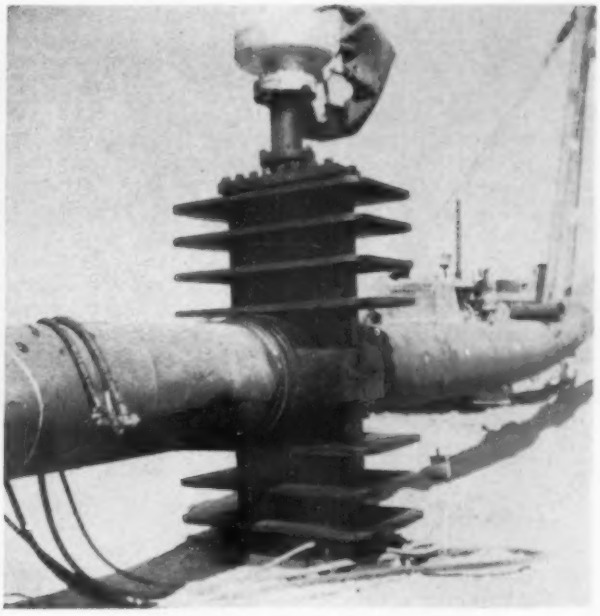
Spain announces plans to build a 150-mile, 14-in. crude oil pipeline from Malaga to Puertollano. Scheduled for construction in 1962, the $10,000,000 pipeline will have an annual capacity of approximately 18,000,000 bbl.

Syrian ministry of industry reportedly has announced bids will be opened before the end of the year on a pipeline linking Kagatchok oil fields with the Mediterranean. The proposed line will be approximately 16 in. in diameter and 435 miles in length. Tender will call for provision of six pumping stations and eight approximately 75,000-bbl-capacity storage tanks at Tartus.

Kuwait Oil Co. will install a crude oil pipeline between its Minagish field and the storage tank farms at Ahmadi. The 30-mile line will be constructed in equal lengths of 22,

EL PASO NATURAL GAS COMPANY PROTECTS LINE VALVES WITH ROSKOTE COLD-APPLIED MASTIC

Roskote cold-applied mastic was spray-applied to 30" valves by El Paso Natural's personnel at Grants, New Mexico. Risers and support legs were coated with Roskote and wrapped with Royston Glas-Wrap for additional mechanical abrasion protection.



On the El Paso Natural Gas Company line being laid at Fort Stockton, Texas, by Western Pipeline Company, all 20" valves were spray-coated with Roskote cold-applied mastic.

You get superior protection against the most severe field corrosive agents with Roskote cold-applied mastic. Valves, risers, line pipe, tanks and other structures above or below ground are coated with Roskote by spray or brush without heat, flame or toxic and irritating effect on workers. The quick-drying feature of these mastics permits early backfilling. Roskote's time-saving, cost-saving application complements its low first cost to provide you with the most economical means of long-life metal protection.

Roskote is applied cold winter or summer. It retains its plasticity at 0° F., and will not run or sag at 250° F. Its high dielectric strength and resistivity, and its superior resistance to acids and alkalies provides ample protection even under the most rigorous underground or atmospheric corrosive conditions. Specific formulations are available for resistance to high crude oil concentrations and gasoline seepage in surrounding soil.

Royston engineers will give prompt attention to your inquiry.

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24 and 26-in. diam. Capacity initially will be slightly less than 100,000 bbl per day and can be increased through installation of gas-expansion, turbine-driven centrifugal pumps. Construction is expected to begin this winter and operation by May, 1962.

FPC Filings

Arkansas Louisiana Gas Co., Shreveport, La., CP 62-19, filed July 24, 1961. *Construction:* 265-hp compressor unit at Hunnewell station north of the Kansas-Oklahoma state line near South Haven, Kan.

Cost: $68,600 which includes: skid-mounted unit, $38,000; sheet metal, closed buildings, $3000; compressor piping, $11,600; fuel meter and regulator, $1000; foundation, $2000; ground improvements, $800; installation of station, $4000; miscellaneous materials and labor, $1500; engineering and supervision, $1000; warehouse charge, $2700; general overhead, $3000.

Manufacturers Light and Heat Co., Pittsburgh, Pa., CP 62-9, filed July 17, 1961. *Construction:* approximately 1975 ft of 8-in. and 2750 ft of 4-in. from a point in Jefferson County, Ohio, across the Ohio River, plus metering and regulating equipment, to provide service to Crescent Brick Co. in Clay District, Hancock County, W. Va.

Cost: $105,000 which includes: pipe, $6159; 200 ft of 12-in. OD casing, $656; 200 ft of 8-in. OD casing, $326; 30 river weights, $2700; fittings and valves, $3200; corrosion materials, $2836; measuring and regulating equipment, $4700; miscellaneous materials, $2123; construction charges and labor, $4200; estimated construction by contract, $63,000; right-of-way and damages, $3500; overhead on construction, $3900; other costs, $7700.

El Paso Natural Gas Co., El Paso, Tex., CP 62-28, filed Aug. 2, 1961. *Construction:* 2.4 miles of 4½-in. gathering lines from Shell Oil Co.'s no. 1 well in the James Ranch producing area, Los Menderos field, Eddy County, N. M., to applicant's 12-in. Eunice-Carlsbad line in Eddy County, plus wellhead dehydration unit and one high pressure well tie and meter run.

Cost: $27,667.

Kansas-Nebraska Natural Gas Co., Inc., Hastings, Neb., CP 62-7, filed July 14, 1961. *Construction:* 3125-hp compressor at Northport, Neb., station (between Sidney and Alliance) and retirement of 3125-hp compressor at Holdredge, Neb., station.

Cost: $70,000 at Northport, which includes: survey, $300; materials, $56,650; labor, $9700; engineering and inspection, $1000; administration and overhead, $2350. At Holdredge, a total of $1000, which includes: materials, $200; labor, $600; engineering and inspection, $200. Because salvaged material totals $23,000, final cost is $48,000.

New York State Natural Gas Corp., Pittsburgh, Pa., CP 62-25, filed July 28, 1961. *Construction:* 23-mile, 12-in. from Aurelius, near Auburn in Cayuga County, to existing regulator at the Phelps connection in Ontario County, N. Y., plus Lester Road measuring station at Phelps connection, the whole facility to be known as the Phelps line.

Cost: $1,038,447 total which includes: pipeline materials, $497,564; freight, $33,000; construction, $311,250; inspection, $13,920; miscellaneous, $123,610; engineering and supervision, $29,380; measuring station materials, $21,400; labor, engineering, etc., for measuring station, $8323.

Ohio Fuel Gas Co., Columbus, Ohio, CP 62-2, filed July 3, 1961. *Construction:* delivery point and facilities, tap on Texas Eastern Transmission Corp.'s main line facilities, together with measuring and regulating facilities (identical with point of delivery proposed by Texas Eastern in companion application, CP 62-3, for sale of natural gas to Dayton Power and Light Co. for New Holland, Ohio, and vicinity.

Cost: $26,000.

Texas Eastern Transmission Corp., Houston, Tex., CP 62-3, filed July 6, 1961. *Construction:* metering and regulating station and appurtenant facilities approximately five miles west of applicant's station No. 17 on its main line in Fayette County, Ill.

Cost: $26,300 which includes: structures and improvements, $2500; pipe, $200; fabrication, $2200; valves and regulators, $3650; meters and instruments, $4150; other material, $2600; installation costs, $11,000.

CP 62-10, filed July 18, 1961, jointly with William E. Snee, Orville Eberly, Robert E. Eberly and L. N.

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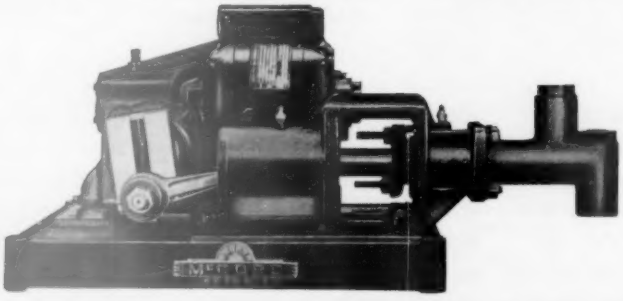

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Murray, for authority to acquire Snee & Eberly's oil, gas and mineral lease in Accident field, Garrett County, Md., together with all facilities thereto, and for authority to construct and operate pipeline connecting the field to its system.

Cost: $1,166,400 which includes: $1,074,000 for pipeline; $44,000 for measuring station; $22,000 for general plant and equipment; $6400 for interest; $20,000 for securing certificate.

Trunkline Gas Co., Houston, Tex., CP 62-16, filed July 20, 1961. *Construction:* 491 ft of 4½-in. OD pipe in Hidalgo County, Tex., near Rio Grande River and Mexican border, between applicant's 8-in. and Texas Eastern Transmission Corp.'s 30-in., plus dual 4-in. measuring station, for short-term sale to Texas Eastern on interruptible basis.

Cost: $15,000 which includes: pipe, labor and right-of-way, $5000; measuring station, $10,000.

United Gas Pipe Line Co., Shreveport, La., CP 62-12, filed July 19, 1961. *Construction:* extensions to serve direct industrial customers. If authority is granted, applicant will submit, prior to March 1, 1963, a report showing total cost, description and location of such facilities.

Cost: Not to exceed total of $750,000.

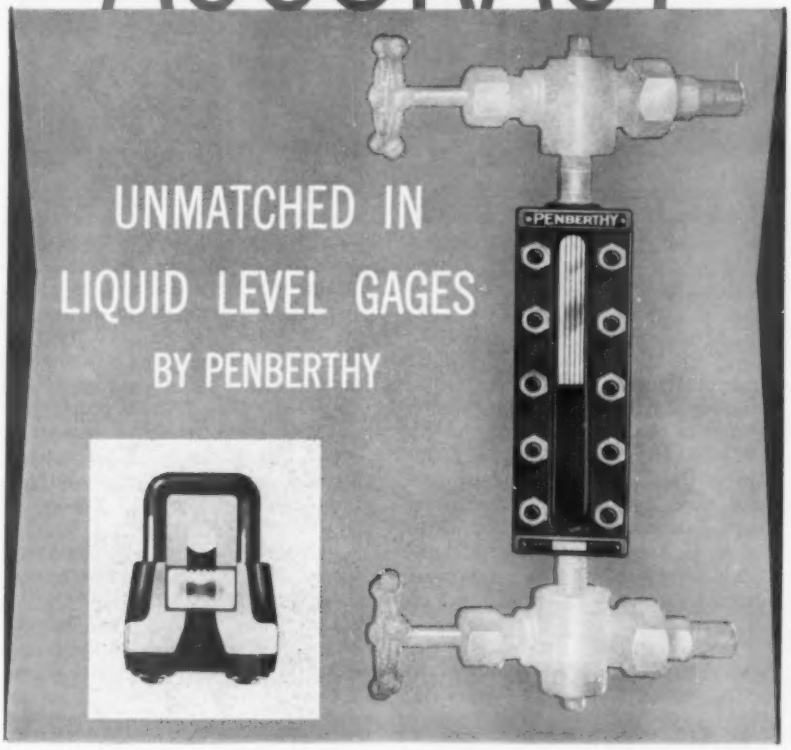
CP 62-24, filed July 27, 1961. *Construction:* connections from new areas, fields and sources of supply from time to time during 1960.

Cost: Not to exceed $3,000,000, with no single connection to exceed $400,000.

SEC Report

Rocky Mountain Natural Gas Co., Inc., seeks to finance construction of about 72 miles of transmission lines and distribution facilities to serve certain communities on the western slope of the Rocky Mountains, 200 miles west of Denver, as well as construction of a tri-town project 25 miles north of Denver. The company seeks registration of $1,500,000 of sinking fund debentures due 1981, as well as 150,000 shares of common stock to be offered for sale in 75,000 units each consisting of $20 of debentures and two common shares. Of the net proceeds, $2,000,000 will be applied to the western, or Roaring Fork, project; $160,000 to the tri-town project; and the balance to general funds.

ACCURACY



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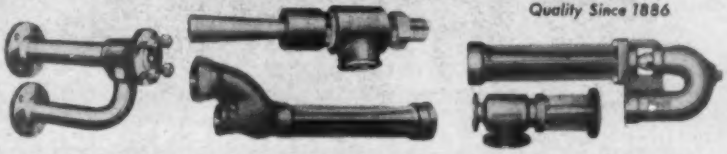

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Pipeline People

R. W. Campbell, vice president and general manager of Home Oil, Ltd., Calgary, Alta., has been elected to the board of directors of Trans-Canada Pipe Lines, Ltd. Other new board members are: N. J. McKinnon, president and chief executive officer of the Canadian Imperial Bank of Commerce, Toronto, Ont.; Beverley Matthews, CBE, QC, senior partner in the law firm of McCarthy & McCarthy, Toronto; V.W.T. Scully, CMG, FCA, president and chief executive officer of The Steel Co. of Canada, Ltd., Hamilton, Ont., and E. L. Kennedy, partner of Lehman Brothers, New York investment bankers.

Four Magnolia Pipe Line Co. supervisors have been advanced to key positions. They are: Wayne M. Harris, superintendent of operations for the Midland, Tex., division, formerly superintendent of the Midland district; Homer Cranfill, superintendent of the Sweetwater, Tex., district, formerly chief gager for the Wichita Falls, Tex., district; Bennie B. Balke, superintendent of the Wichita Falls district, formerly Healdton, Okla., area supervisor, and Kenneth B. Snider, superintendent of the Seminole, Okla., district, formerly supervisor of the Andrews, Tex., area.

Service Pipe Line Co. has transferred Kenneth H. Bowman, engineer, from Galesburg, Ill., to Casper, Wyo., where he replaces Herschel Evans who was promoted to division schedule coordinator for the Wyoming division.

Burton F. Wiand, vice president and director of Cities Service Gas Co., Oklahoma City, Okla., is being transferred to the parent Cities Service Co. in New York City to coordinate industrial relations and public affairs activity for the organization. He has been with Cities Service Gas Co. since 1952, when he was placed in charge of that company's public and industrial relations program.

Kenneth S. Shoemaker has been appointed assistant superintendent of the eastern products division of The Buckeye Pipe Line Co. Robert J. Rippon, formerly chief deliveryman at Utica, N. Y., is succeeding Shoemaker in his former position as right-of-way agent.

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Seeking . . . and finding, better communication systems is part of our life at USI. Sure in the knowledge that one of our systems can serve you best, we invite your next bid. Better still, why not call us today!
TYPE 50A PX
TYPE 50B PX
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Pipeline Equipment

New Truck Crane Design

Four new truck crane models feature: 4-axle design carrier for lighter loading and balanced weight distribution; heavy-duty alloy steel frame in balance with rotating assembly; rotating base, rear end unit and machinery side frames in one welded assembly; and in-line shaft designed to achieve low center of gravity. A third hoist drum and power load lowering can be installed, as well as reduction gear unit. Conventional roller path, center pintle, cone and hook rollers are eliminated. All four models operate on a ball bearing swing circle with integral swing gear. The new models are: 250-T (25-ton capacity, 300-T (30-ton capacity), 350-T, (35-ton capacity) and 450-T (45-ton capacity). Maximum crane booms: from 170 ft on the 250-T to 180 ft on the 450-T. Boom and jib combinations: from 180 ft to 200 ft. *Baldwin-Lima Hamilton Corp.*

Circle number (81) on reply card

Meters Cataloged

Rotocycle meters for all liquid metering applications are the subject of a new catalog. Micro adjustment calibration is explained and illustrated by theoretical example. A total of 13 accessories illustrated include registers, temperature compensators, electrical impulse contactors and remote registration equipment. *Rockwell Manufacturing Co.*

Circle number (82) on reply card

Flo-Balls Featured

A 16-pager catalogs the complete Flo-Ball valve line — with cutaway drawings, phantom and exploded views, materials of construction charts, pressure/temperature curves and dimension tables and drawings. *Hydromatics, Inc.*

Circle number (83) on reply card

Welders Described

Designed to perform equally well in the shop or at outdoor construction sites is the new Idealarc R3M 3-phase rectifier-type d-c arc welder. According to a new bulletin, it can handle any type of manual arc welding electrode. *The Lincoln Electric Co.*

Circle number (84) on reply card

New "SWEEGEE" PIPELINE PIGS

- Safe
- No Metal Parts
- Light Weight
- Easy to Handle
- Economical
- Flexible

16" and 36" SWEEGEES

The SWECO "SWEEGEE"* is used in pipelines for removal of water after hydrostatic tests, removal of sand and debris, and for purging of air. The "SWEEGEE" will perform virtually all functions of the conventional cup-type pig. The "SWEEGEE" fits all pipeline jobs . . . gas, crude, product, and performs well in LPG service.

The "SWEEGEE" has been purchased and proven in use by many pipeline companies.

The foamed, homogeneous construction assures continuous, full-surface contact through bends, sags, valves and chill rings. The "SWEEGE" will go around 90° or 180° bends, pass through lines with varying wall thicknesses, such as river crossings, as well as through pipe with varying diameters.

It is excellent for use in internally-coated pipe since it contains no metal. It's easy to handle due to the extreme light weight. An 8-inch "SWEEGE" weighs less than a pound, a 20-inch less than 15 pounds. The cost is so low that a large inventory can be maintained with a small investment. In many cases, the cost of one "SWEEGEE" is less than that of just one cup for a conventional cup-type squeegee of the same size.

Manufactured by SWECO, Inc., Prudential Bldg., Houston 25, Texas
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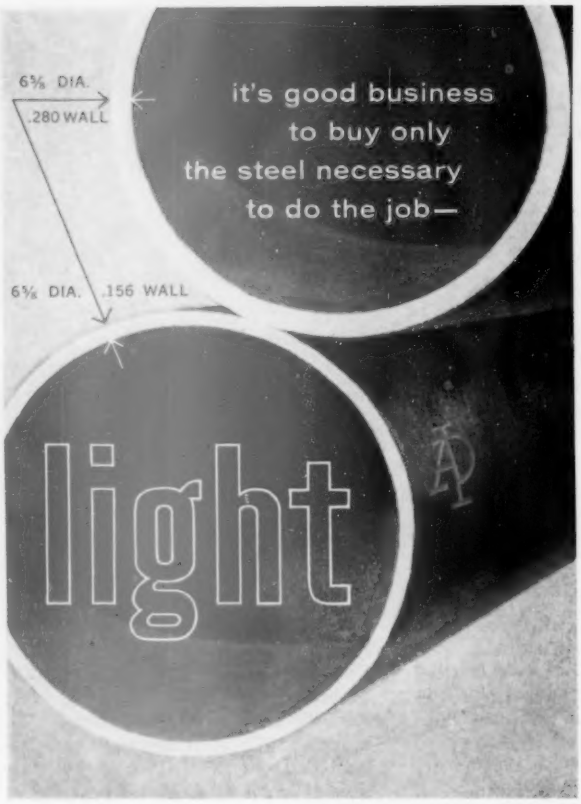

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For gathering and distribution lines save as much as 33%. Approximately $365,000 in pipeline cost was saved by specifying and buying Southern Pipe Lite-Wall pipe. (Company name on request.) The job called for a 147-mile, 5⅝" petroleum products line. Lite-Wall pipe cut cost by more than ⅓. For economical water flood installations Southern Pipe Lite-Wall pipe can be mortar-lined and wrapped or coated. Top quality sand and materials used. Fabricated and shipped from one installation at less cost to you. Exacting quality control to your specifications. Unique PreSeal joint eliminates welding, provides positive seal, lowers installation costs. Southern Pipe Lite-Wall pipe is manufactured to API specifications from 3½" to 14" O.D.

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Units Get Better Track Links

Track link improvements that result in longer service life have been announced for six Cat-built units. On the D7 tractor, 977 loader and 572 pipelayer, cross-sectional area of the rail has been increased by 12% for greater structural resistance to breakage, to reduce peening over the sides as wear limits are reached and to lessen distortion during rebuilding. Strut width and thickness also have been increased to give higher resistance to fatigue cracking and to increase overall strength. Links for the D6 tractor, 955 loader and 561 pipelayer are now Hi-Electro hardened. This additional process results in a harder wearing surface, with approximately 25% longer service life, and improved pin and bushing retention. The MD-6 pipelayer is affected by these design improvements. *Caterpillar Tractor Co.*

Circle number (85) on reply card

Entire Compressor Line

Westinghouse unit type and Le Roi stationary air compressors are now combined in one illustrated bulletin. Unit type compressors from ½ to 15 hp for displacements up to 70 cfm are described, as well as stationary models from 25 to 100 hp for industrial air supply. *Le Roi Div., Westinghouse Air Brake Co.*

Circle number (86) on reply card

Crane-Excavator Described

A crane-excavator, the Koehring 605, rated as a 1½-yd shovel and 36-ton crane, is fully described in a two-color bulletin. *Koehring Div.*

Circle number (87) on reply card

Data On Rootsmeters

Line-Mounted Rootsmeter data is available. A brochure cites features, and detailed specifications include construction features, dimensions and capacity ratings at various operating pressures. *Roots-Connersville Blower, Div. of Dresser Industries, Inc.*

Circle number (88) on reply card

Pictures Traxcavator Uses

"Do More Jobs Easier" is an 8-page booklet showing, under working conditions, three wheel-type and three track-type Traxcavators. What applications each machine best fits and the qualifying features are discussed. Popular attachments are pictured. *Caterpillar Tractor Co.*

Circle number (89) on reply card

Aircomatic Welder Featured

The Aircomatic pipe welder that speeds pipeline welding without pipe rotation is now the subject of a brochure covering all features of the new development — how the process works, practical advantages and the equipment required. Of particular interest is a full page of photographs showing the unit in test operations in Odessa, Tex., fields. *Air Reduction Sales Co.*

Circle number (90) on reply card

Flexible Couplings Data

A 24-page bulletin includes product photographs, engineering drawings and actual installation pictures of an expanded line of Para-flex flexible cushion couplings that absorb vibration and compensate for all combinations of shaft misalignment and end float. *Dodge Manufacturing Corp.*

Circle number (91) on reply card

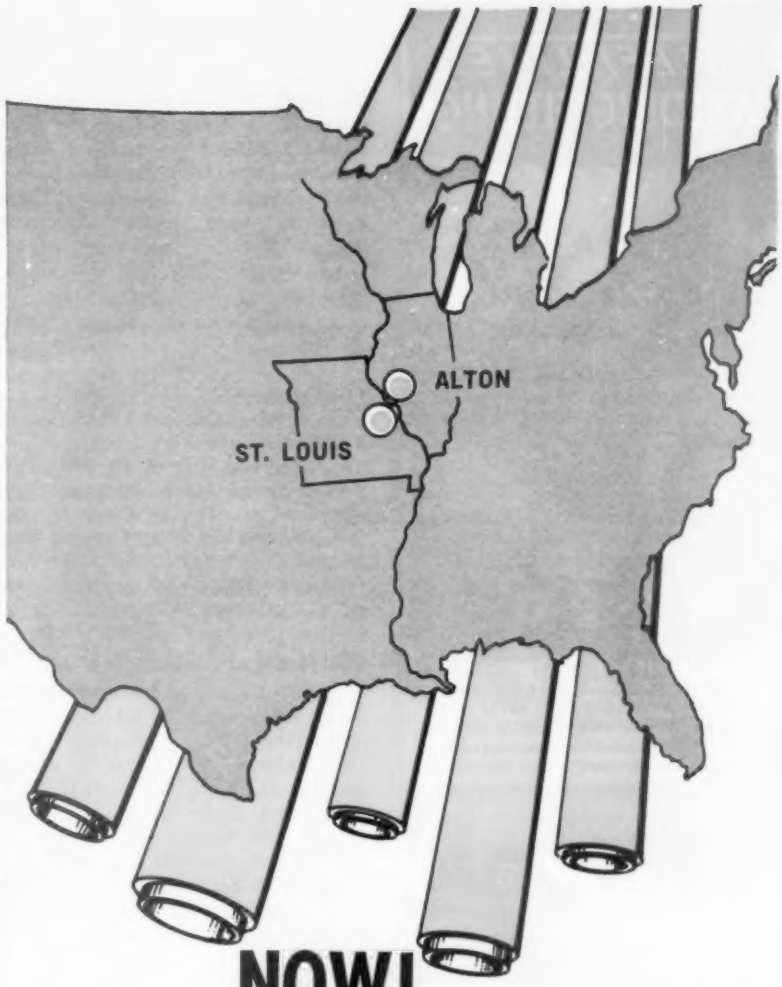
Gasoline-Powered Boring Unit

The Ka-Mo G-160, a gasoline powered horizontal boring unit, can bore 36-in. diam holes. The compact, self-contained unit consists of: 52-hp air-cooled gasoline engine; hook rollers and engine base; 3-speed transmission and gear reduction with clutch; 9 gpm hydraulic pump powering feed mechanism; leveling outriggers; track; and connecting plates. Ratings range from 150 ft of 36-in. diam hole to 200 ft of 12-in. diam. Power driven feed eliminates danger of deadman anchor. *Kwik-Mix Co.*

Circle number (92) on reply card

Midget Leak Detector

One of the features of the electronic model ML-61 leak detector is its operating weight of 20 oz. The aluminum case which houses all electronic parts including three transistors, batteries and circuitry, is just 5 in. x 1¾ in. x 2⅛ in. The sensitive 1-in. sq Rochelle Salts crystal microphone has a special mounting assembly that accepts important leak vibrations and minimizes extraneous, unwanted sounds. An electronic filter circuit assists in de-



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from SPI's new Alton, Illinois Plant comes STANDARD X-TRU-COAT

Standard Pipeprotection's new plant at Alton, Illinois has been shipping Standard X-Tru-Coat pipe to the Southwest and West since early July. Sizes available include ¾" Nom. through 4½" O.D.

X-Tru-Coat high density polyethylene plastic coating for pipe is produced under the DeKoron process — Pat. Nos. 2,447,420 and 2,467,642 — and is extruded on pipe over a pressure sensitive adhesive.

Standard Procedures assuring top quality prevail at the Alton, Illinois plant, as they have for many years at SPI's coating and wrapping plant in St. Louis. In-Transit privileges are available at both plants from any pipe mill.

Standard Pipeprotection, with the introduction of X-Tru-Coat, has continued to contribute to the progress of the oil and gas industry.

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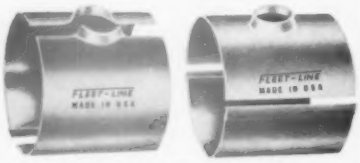

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tecting only important leak noise. Other features are: on-off switch and gain control combined under one knob; headphones permanently wired in; and battery supply from four standard 1½-v penlight cells. Accessories include machined probe, cast aluminum "resonator" and mounting base, leather carrying case and detailed operating instructions. Weight of the unit with accessories is 1¾ lb. *Goldak Co., Inc.*

Circle number (93) on reply card

Digital Logger Data Sheet

Block diagrams demonstrate how a physical property (such as flow, pressure, etc.) is measured, converted to an electrical input and delivered in digital form by the Data-Master Digital Logger. *The Bristol Co.*

Circle number (94) on reply card

Crawler Improvements

A bulletin lists 56 improvements on a crane-excavator which is fully convertible for crane, dragline, clamshell, shovel or stripping shovel operations. Notable improvements have been made on the revolving frame, deck machinery, power units, air controls, crawlers and front ends of the 88-B Series Two. As a shovel it is equipped with 5 cu yd dippers, as a dragline with 4- to 7-cu-yd buckets, and as a clamshell with 4- to 6-cu-yd buckets. *Bucyrus-Erie Co.*

Circle number (95) on reply card

Worm-Gear-Driven Valve

A catalog introduces a worm-gear-operated, non-lubricated ball plug valve which is said to operate easier and with less torque on the handwheel. The plug is mounted on sealed bearings. The worm-gear mechanism is completely enclosed. *Hydril Co.*

Circle number (96) on reply card

Gas Compressor Described

A compact, lightweight, 3-stage, air-cooled natural gas compressor is said to be ideal for packaging into economical, portable, skid-mounted units driven by an engine or an electric motor. A bulletin describes the XG-3 and such features as: short stroke to produce low piston speeds; Worthington feather valve that has only one moving part; forced feed lubrication; separator with automatic condensate drain following second-stage intercooler; and oil pressure gage and interstage discharge pressure gage conveniently located on fan guard. *Worthington Corp.*

Circle number (97) on reply card

High Volume Gas Flow

A line of check valves has been designed especially for use with large volume gas flow to provide protection from system surge, backflow and other problems. Rapid, quiet response with efficient straight-through flow and low pressure drop

are the outstanding operating characteristics. There are no rotating, sliding, hinged or high inertia moving parts to wear or develop leaks. These compact valves can be mounted horizontally, vertically or at any angle in a pipe or compressor discharge line. They are offered for pressures to 1000 psi and are available with cast iron, cast steel or alloy steel bodies in pipe sizes 6 to 48 in. *Clark Bros. Co., Div. of Dresser Industries, Inc.*

Circle number (98) on reply card

Calculating Pressure Drop

To shed new light on calculating pressure drop through lubricated plug valves, a 12-pager has been issued. It lists 85 Walworth lubricated plug valve figure numbers from which the engineer may select data and calculate pressure drop with either the K-values or equivalent feet method. *Walworth Co.*

Circle number (99) on reply card

X-Tru-Coat Folder

Hill Hubbell X-Tru-Coat, the high-density polyethylene pipeline coating that is bonded to steel pipe by a "live" adhesive, is the subject

of a 4-pager. Featured are a corrosion resistance table and sketches of typical applications. *Hill Hubbell Co.*
Circle number (100) on reply card

Conversion Chart Available

A reference table for engineers is the free wall chart that includes such common conversions as inches to centimeters or watts to hp and many that are difficult to locate in reference manuals. Some examples are: atmospheres to kgs/sq cm; cm/sec to miles/hr; cu ft to liters; microns to meters; and quintal to lb. *Precision Equipment Co.*
Circle number (101) on reply card

Lit Presents Metagraphic

Introduction of a pneumatic receiver with 4-in. chart width is made in new literature. It discusses the Metagraphic's removable chart-drive mechanism, capillary inking system, and elimination of "seal" position from control function switch. *The Bristol Co.*
Circle number (102) on reply card

High Pressure Float Control

Descriptive literature on this new control calls attention to its unique sight glass arrangement for visual level indication, positive displacement type float, throttling pneumatic output and hammer union connection. *Instruments, Inc.*
Circle number (103) on reply card

Engine-Compressor Details

Balanced-opposed engine-compressors for continuous, heavy-duty service are discussed in a 4-page bulletin. Features and construction details are summarized, with appropriate illustrations. *White Diesel Engine Div.*
Circle number (104) on reply card

Valves For Specific Uses

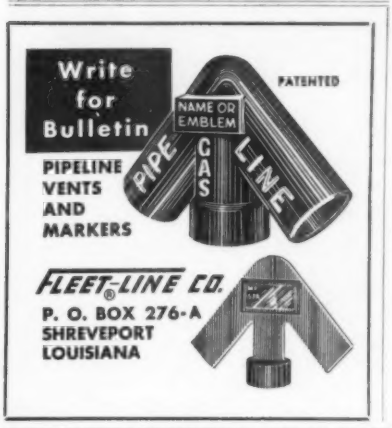
Valves developed from several different flow concepts, each engineered for specific applications, are featured in a new catalog. Actuators and accessories to which these valves are readily adaptable are described. *Security Valve Co.*
Circle number (105) on reply card

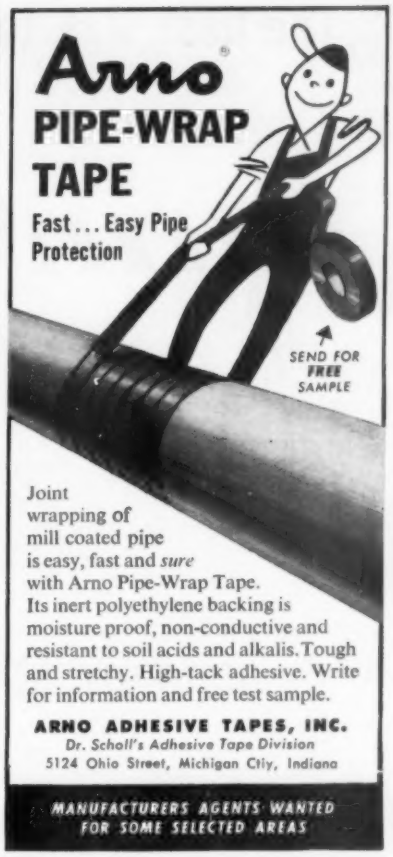
Lists Engine Safety Systems

An engine safety control system catalog contains full description of a number of pneumatic systems incorporating safety shutdown or warning upon malfunction of measured variables such as temperatures, pressures, levels, speed and vibration. Also described are individual components such as relays, indicators and receivers. *Fulton Sylphon Div., Robertshaw-Fulton Controls Co.*
Circle number (106) on reply card

Bearing Terms Defined

Newcomers in the rolling contact bearing field will be interested in a 24-page booklet, "Bearing Parts and Nomenclature of Standard and Precision Bearings." It defines and illustrates ball and roller bearings parts

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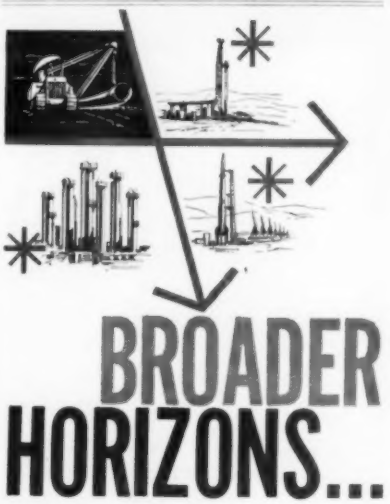
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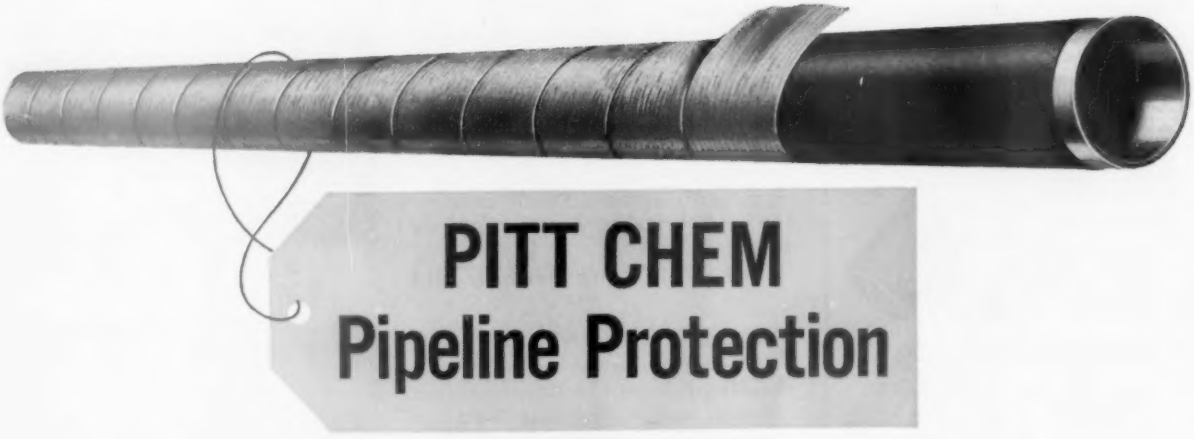

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Pitt Chem Coal Tar Enamels have a long record of maintenance-free protection in the gas industry. They are produced to highest quality standards—quality *proven* by their record of resistance to moisture penetration, year after year. Specify Pitt Chem protected mill coated pipe for your distribution lines and Pitt Chem Coal Tar Coatings for joint protection and patching. A Pitt Chem sales representative will be glad to give you more information and help you plan a long-term, economical Pitt Chem Pipeline Protection Program.

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and terms and includes data on ball installation, dimensions, loads, alignment, and types and functions of self-aligning, non-self-aligning and thrust bearings. *SKF Industries, Inc.*

Circle number (107) on reply card

Flanged Coupling Folder

"Flexible Flanged Coupling Adapters" is a 12-page, 2-color brochure giving detailed information on how these fittings can be incorporated into design of water or gas systems or used for "cutting-in" flanged fitting installations in existing pipelines. Charts show complete range of plain-end and machined-end pipe sizes and flanged fittings that can be accommodated. *Smith-Blair, Inc.*

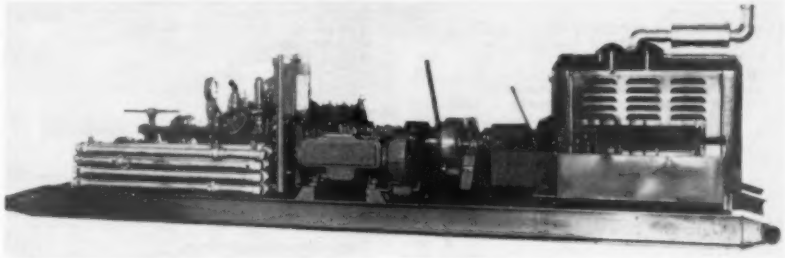
Circle number (108) on reply card

In-Line Processing

The modular, transistorized RPC-9000 is an automatic, in-line system that processes and up-dates records from start to finish in one continuous flow, with processing performed in random order. Batching is not necessary or required. A decimal machine, it handles both alphabetic and numeric data with equal facility. Simultaneous input and output is possible with up to 32 separate on-line devices. It utilizes nickel wire, magneto-strictive delay lines for internal storage; magnetic tape for general file storage. Main memory or data storage element with the RPC-9100 magnetic tape storage unit consists of a magnetic loop of tape that moves at high speed in one direction with reading and recording performed at separate stations. Auxiliary equipment includes a 500-character-per-sec photo-reader, 400-cards-per-min punched card reader, 300-characters-per-sec high speed aper tape punch, line printer and on-line or off-line tape typewriter system. *Royal Precision.*

Circle number (109) on reply card

Pipeline Tester Introduced



A compact, self-contained hydrostatic pipeline tester that features ease of operation is introduced in new literature. The Apex 6021 and companion supplementary unit, 6022, are said to fill all pipeline testing requirements and to offer many plus factors including elimination of danger inherent in present use of compressible materials. The 6 cylinder diesel power unit is coupled directly to the centrifugal fill pump which is capable of delivering 800 gal of water per min at 300 psi. The quintiplex pressure pump is driven from the diesel power unit through two roller chain and sproket speed reducing drives. *Apex Machine and Manufacturing Co.*

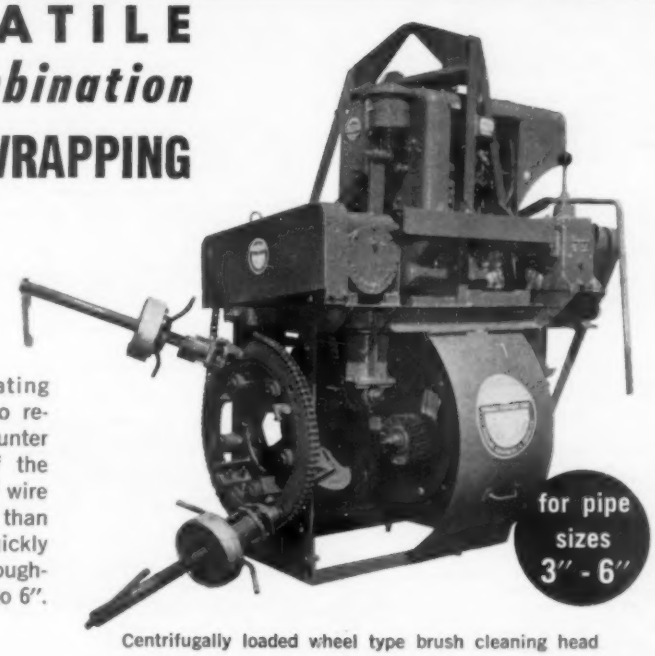
Circle number (110) on reply card

NEW • VERSATILE

CROSE-PERRAULT *Combination*

CLEANING & TAPE WRAPPING MACHINE

The new Crose cleaning and tape wrapping machine offers a new design and improved mechanical cleaning of pipe with twisted wire wheel type brushes revolving at high speed. Self-compensating brushes are long-wearing and economical to replace. Only one head is used, but a counter rotating effect is employed by rotation of the cleaning sprocket and an opposite rotation of wire brushes. Lower fuel consumption, less weight than comparable conventional machines. Can quickly be adjusted from one pipe size to another throughout range of machine. Handles pipe from 3" to 6".



Centrifugally loaded wheel type brush cleaning head

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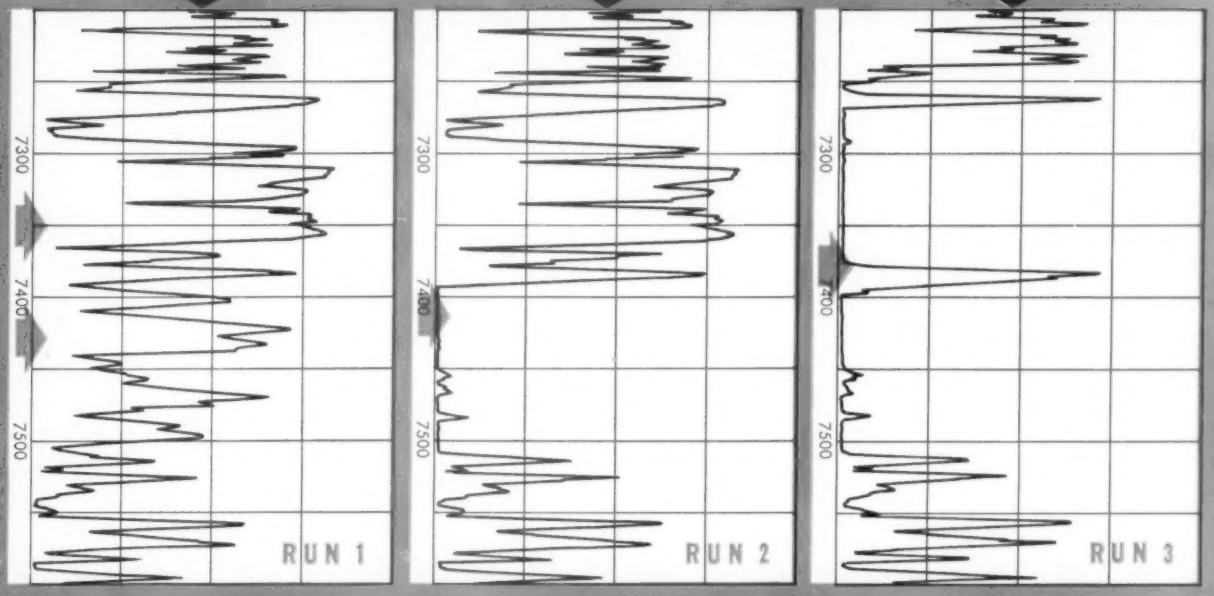
DOES THIS WELL NEED A SQUEEZE JOB?

DID YOU GET AN EFFECTIVE SQUEEZE?

DID YOU ISOLATE THE PRODUCING ZONE?



In this well, Lane-Wells Cement Bond Log showed no bonding in the zone of interest, indicated necessity of a squeeze job.

After perforating at 7414', well was squeezed with 88 sacks of cement. Second Cement Bond Log showed bonding from 7394' to 7510'.

Well was perforated at 7378' and squeezed with 100 sacks of cement. Third Bond Log showed good bonding from 7269' to 7378'. Oil produced in zone from 7382' to 7390'.

Lane-Wells Acoustic Cement Bond Log

helps establish cement effectiveness with minimum equipment–without costly delays

Because it helps you "see" the cement column in a potential producing zone, Lane-Wells Acoustic Cement Bond Log is your best way to answer questions like those above. Run immediately following a primary cement job or prior to remedial operations, it can save rig time and avoid costly losses.

ACCURATE Significant information is contained in the first arrival signal, and all Lane-Wells units are equipped with an oscilloscope for viewing the acoustic signal at the receiver to assure pick of the first arrival.

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